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VOL. XVIII • NO. 1 • JANUARY 1980

# DEVELOPMENT DIGEST

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 2, 1966.

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# DEVELOPMENT DIGEST

A quarterly journal of excerpts, summaries, and reprints
of current materials on economic and social development

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Lowell Shaffer, Digest Secretary
Prepared by the National Planning Association

for

Agency for International Development, U.S. Department of State

## TO READERS OF THE DEVELOPMENT DIGEST

The January 1979 issue of the Development Digest had a questionnaire for readers which a number of you completed and sent to the Agency for International Development in Washington. Later in the year, a second and more elaborate questionnaire was mailed to a number of people who had answered the first one, as well as to readers selected from the overall mailing list. At present all these questionnaire results are being analyzed.

We in the Agency for International Development, and the editors of the Digest, would like to thank all of you who have given us your assistance by returning these questionnaires. In the next issue of the Development Digest we will give you a comprehensive report on these questionnaire results, which indicate Digest readers' views on subjects in the journal and other related matters.

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# Industry in Developing Countries: Some Recent Trends

UNIDO

[This extract from a UNIDO survey of world industry since 1960 deals with employment, labor productivity, technology, and rural industry, and some of the differences between developing and developed economies.]

## Comparative Growth Trends in Manufacturing

Analysis of the growth trends in employment, output (value added), and labor productivity in manufacturing over the 16 years from 1960 through 1975 (Table 1) reveals great divergencies among the three country groupings. It is evident that the developing countries registered a strong, though uneven, growth in manufacturing employment in this period at faster rates than in the developed-market or centrally-planned economies. The annual growth rate for developing countries was 4.9 percent in 1960-1975; in the shorter period 1968-1975, growth accelerated to achieve an average of 7.0 percent per annum.

These growth rates for the developing countries are not only high in comparison with those attained by the other two main groupings, but high measured against historical levels. High rates of growth in employment were associated with still higher growth in output, so that labor productivity in the manufacturing sector of the developing countries has risen over the period. However, it is evident from the data in Table 1 that the gap between productivity in these countries and that in the other groupings widened, since the productivity gains in the more developed countries were clearly greater.

Report of the United Nations Industrial Development Organization (UNIDO) with headquarters in Vienna, Austria

## TABLE 1

### Annual Growth Rates of Manufacturing Employment, Value Added, and Labor Productivity, 1960-1976

| | Employment | | Value Added | | Labor Productivity | |
|---|---|---|---|---|---|---|
| | 1960-1975 | 1968-1975 | 1960-1975 | 1968-1975 | 1960-1975 | 1968-1975 |
| Developing countries | 4.9 | 7.0 | 7.4 | 9.1 | 2.4 | 2.0 |
| Latin America | 4.7 | 7.9 | 8.0 | 9.7 | 3.2 | 1.7 |
| Asia | 4.4 | 6.5 | 6.9 | 8.1 | 2.4 | 1.5 |
| Developed market economies | 0.9 | 0.4 | 5.7 | 4.1 | 4.8 | 3.7 |
| Centrally planned economies | 3.4 | 2.6 | 10.0 | 10.7 | 6.4 | 7.9 |
| World average | 2.8 | 2.9 | 7.1 | 6.5 | 4.2 | 3.5 |

Source: *Statistical Yearbook* 1977 (United Nations publication, Sales No. 78.XVII.1); *Yearbook of Industrial Statistics*, 1976 Edition, Vol. I (United Nations publication, Sales No. 78.XVII.3E); and data supplied by the United Nations Statistical Office.

The growth of manufacturing output and employment in the developed market economies exhibited cyclical fluctuations in the 1960s, followed by stagnation from the beginning of the 1970s and then a decline in 1974 and 1975. Typically for the initial period of a recession, the contraction in employment in 1974 and 1975 was somewhat smaller than the decrease in output. The centrally planned economies maintained a relatively steady growth of output and employment, although the rate of employment growth has been declining since 1968. The labor force in these countries was growing at a slow rate; while labor shortages were being felt in some sectors of the centrally planned economies, agriculture still absorbed more than one third of the total labor force of these countries.

Some recent data on trends in employment expansion from the early 1970s are available for 35 developing countries, and are presented in Table 2 with corresponding data on the growth of the total and the non-agricultural labor force in 1970-76. Growth rates in the supply of labor ranged from 1.1 percent per annum in Jamaica to 3.7 percent in Venezuela; in most countries it was increasing at a rate above 2.5 percent. Only four countries, at different levels of *per capita* income, experienced a contraction of employment in manufacturing during the period: Chile, Guatemala, Sri Lanka and Uganda.

## TABLE 2

## Annual Growth Rates of the Labor Force in the Whole Economy, Non-Agricultural Sectors, and Manufacturing, 35 Developing Countries, 1970 to 1976

(Percentages)

| Country or area, by income group[a] | Total labour force[b] | Employment in non-agricultural sectors | Employment in manufacturing |
|---|---|---|---|
| *Low (<$265)* | | | |
| Ethiopia | 1.95 | ... | 4.0[b] |
| India | 1.96 | 2.6 | 2.1 |
| Kenya | 2.60 | 6.6 | 6.5 |
| Malawi | 1.91 | 7.0 | 9.3 |
| Pakistan | 2.50 | 5.0 | ... |
| Sierra Leone | 1.81 | -1.6 | 1.3[b] |
| Sri Lanka | 2.51 | 3.6[c] | -1.4[c] |
| *Lower middle ($265-$520)* | | | |
| Egypt | 2.45 | 4.5[d] | 3.9[d] |
| El Salvador | 3.28 | 3.7[d] | 5.0[d] |
| Jordan | 2.88 | 9.6 | 6.9 |
| Nigeria | 2.06 | ... | 8.1[d] |
| Philippines | 2.68 | 1.5[c] | 3.8 |
| Thailand | 2.87 | 2.5[e] | ... |
| Uganda | 2.40 | 2.5[f] | -0.5[f] |
| United Republic of Cameroon | 1.37 | 2.2 | 20.0 |
| Zambia | 2.44 | 2.4[d] | 1.6[d] |
| *Intermediate middle ($521-$1,075)* | | | |
| Algeria | 2.84 | ... | 11.5[b] |
| Chile | 2.48 | ... | -0.7 |
| Colombia | 3.19 | ... | 3.4 |
| Cuba | 1.78 | 3.7[g] | 2.7[h] |
| Dominican Republic | 3.08 | ... | 6.7[d] |
| Ecuador | 3.24 | ... | 3.3[d] |
| Guatemala | 2.93 | ... | -3.6[c] |
| Mauritius | 3.26 | 11.1 | 23.7 |
| Republic of Korea | 2.93 | 6.1 | 16.8 |
| Swaziland | 2.18 | 9.4[b] | 13.3[b] |
| Syrian Arab Republic | 2.64 | 6.6[d] | 3.4[h] |
| Tunisia | 2.30 | 6.6[d] | ... |
| *Upper middle ($1,076-$2,000)* | | | |
| Hong Kong | 2.92 | ... | 1.7 |
| Jamaica | 1.10 | 2.5[i] | 3.8[d] |
| Panama | 2.74 | 2.7 | 4.1[b] |
| Trinidad and Tobago | 2.41 | 3.6[j] | ... |
| *High (>$2,000)* | | | |
| Brunei | ... | ... | 7.7[e] |
| Puerto Rico | 2.11 | 1.1 | 0.6 |
| Venezuela | 3.70 | ... | 5.0 |

*Source:* Based on ILO, *Yearbook of Labour Statistics 1977*, and ILO, *Labour Force Estimates 1950-1970 and Projections 1975-2000*, 2nd ed. (Geneva 1977).

*Note:* Rates of growth for the non-agricultural and manufacturing sectors are calculated using regression on time.

[a] According to GNP *per capita* at 1975 dollars. [b] 1970-1975. [c] 1971-1975. [d] 1970-1974. [e] 1972-1976. [f] 1970-1973. [g] 1971-1974. [h] 1972-1975. [i] 1969-1976. [j] 1970-1976.

The data in Table 2 show that the growth rates of manufacturing employment in most developing countries in the period 1970-1976 were much higher than the rates of growth of the labor force, and even of the urban labor force. Many developing countries experienced a phenomenal percentage growth in manufacturing employment, which reflects the small size of the industrial sector in these countries at the beginning of the 1970s. There was a noticeable tendency for employment in manufacturing to grow more rapidly than that for the non-agricultural sectors. The level of *per capita* income, which is normally taken as a proxy for the level of economic development, had little relationship with the performance of the manufacturing sector in generating employment.

## Employment and Productivity

In the manufacturing sector of industrialized countries the regular interaction of output and productivity has been noted and studied. It was found that in a number of these countries productivity increased most rapidly when output was also increasing rapidly --according to the so-called "Verdoorn Law." Fresh evidence in support of this Law is found in a recent ECE study on the growth of industry in Europe. It is doubtful, however, that the same relationships would apply to developing countries. Technical progress, economies of scale, and growth in productivity owing to the process of "learning by doing" are no doubt at work in developing countries as well, but under different social, technical and economic conditions.

Firstly, substantial manufacturing activity in developing countries is carried out in the traditional sub-sector, with the help of part-time manual workers of low productivity. In time this sub-sector tends to shrink, but it is not negligible. Secondly, investment (embodied technical changes) seems to be more concentrated, and capacity utilization tends to be lower in developing countries than in industrialized countries. These factors are unlikely to contribute to a uniform, one-directional effect on output and employment in terms of the benefits of economies of scale, or to provide feedback in the form of the effects of rapidly growing productivity on the structure of demand and investment.

Data for developing countries are scant and not entirely comparable. A cross-country analysis of linear regression of employment growth and productivity growth on output growth, covering nine countries (Argentina, Brazil, Chile, Colombia, Ecuador, India, Mexico, the Republic of Korea and Venezuela) for the period 1968-1974, gives the following results:

$$E = 0.909 + 0.480X;\ R^2 = 0.76;\ t = 4.77$$
$$P = 0.661 + 0.466X;\ R^2 = 0.77;\ t = 4.86$$

where E = employment growth, P = productivity growth, and X = output growth. These results appear to be different from those of the ECE study on the industrialized countries of Europe. For developing countries, rates of employment growth are generally higher, and their contribution to the growth of output is greater than is the contribution of increases in labor productivity; the figures for productivity growth rates in Table 1 suggest a wide difference between the two rates. A plausible explanation for such a difference is that the developing countries with under-employed labor available can undergo a rapid growth in output without a noteworthy growth in productivity. In other words, capital investment "widening" receives greater emphasis than capital "deepening". Similar tendencies seem to have been at work in the late 1950s and early 1960s in the centrally planned economies, when industrialization proceeded under conditions of labor abundance. Now that full employment has been achieved, capital deepening is more pronounced, and the rates of employment growth are decreasing.

A survey of growth trends in employment, productivity and output for different branches of industry in 14 developing countries for which the data were available shows that the general trend towards a more rapid growth in employment than in productivity, observed for the manufacturing sector as a whole, is also discernible at the branch level. Gains in productivity exceed employment gains in less than one third of the countries in the sample, and in only a few branches of industry--textiles, clothing, footwear, wood products, non-metallic minerals products.

The long-term potential for industrial growth and increases in labor productivity and, consequently, for growth in income is linked with the composition of employment in industrial branches. In the early 1950s the criterion for assessing the potential of an industrial branch to induce growth in employment was primarily the capital-intensity of the branch. There is now a growing tendency to use a multi-factor criterion and a multi-stage procedure. The numbers employed per dollar invested are still important, but other considerations such as the potential contribution to technological advance, the development of skills, and the effect on the distribution of the gains of development are also taken into account. Different branches naturally have different potentials for inducing overall growth and technological development. For example, the manufacture of soft drinks (whatever the choice of production technique) and the manufacture of fertilizers or steel offer distinctly different possibilities as stimuli for further industrial growth and technological advance.

Table 3 gives the annual growth rates of employment for branches of industry over the period 1968-1975, together with the growth rates for light manufacturing and heavy manufacturing. Two general observa-

## TABLE 3

## Annual Growth Rates in Employment, by Branch of Industry, 1968-1975

| *Branch* | *ISIC* | *Developing countries* | *Latin America* | *Asia* | *Developed market economies* | *Centrally planned economies* | *World* |
|---|---|---|---|---|---|---|---|
| Food, beverages and tobacco | 31 | 4.8 | 5.7 | 3.9 | -0.4 | 1.5 | 2.3 |
| Textiles | 321 | 5.1 | 3.6 | 4.7 | -2.5 | 1.3 | 2.3 |
| Wearing apparel, leather, footwear | 322-324 | 8.7 | 9.4 | 8.5 | -0.3 | 2.0 | 3.4 |
| Wood and wood products, including furniture | 33 | 8.1 | ... | 8.2 | 0.3 | 1.0 | 3.4 |
| Paper and paper products, printing and publishing | 34 | 6.3 | 7.3 | 5.5 | – | ... | 1.0 |
| Chemicals | 35 | 8.9 | 7.6 | 9.0 | 1.0 | 3.4 | 3.3 |
| Non-metallic minerals | 36 | 7.9 | 9.3 | 7.0 | 0.2 | 2.4 | 3.3 |
| Basic metals | 37 | 14.4 | 9.1 | 17.1 | 0.5 | 1.2 | 2.9 |
| Metal products, machinery and equipment | 38 | 9.5 | 11.1 | 8.7 | 1.0 | 3.5 | 2.8 |
| Light manufacturing |  | 6.2 | 7.0 | 5.7 | -0.4 | 1.6 | 2.8 |
| Heavy manufacturing |  | 9.2 | 9.5 | 8.7 | 0.8 | 3.1 | 2.9 |
| Total manufacturing |  | 7.0 | 7.9 | 6.5 | 0.4 | 2.6 | 2.9 |

*Source: Yearbook of Industrial Statistics, 1976 Edition,* vol. I (United Nations publication, Sales No. 78.XVII.3E).

tions may be made. Firstly, at the industrial branch level, employment growth rates diverged widely in this period, ranging from 17.1 percent for basic metals in Asia and 11.1 percent for metal products in Latin America to - 2.5 percent for textiles and - 0.4 percent for food, beverages and tobacco in the developed market economies.

In developing countries, most manufacturing employment is in traditional industries such as food, textiles and wood products, all of which fall under light manufacturing. Over the period 1968-1975, food, textiles and wearing apparel together accounted for about 46 percent of the total increase in manufacturing employment. In the comparatively more industrially advanced region of Latin America, however, the three branches had a much smaller share in the regional growth of manufacturing employment; the highest growth in employment occurred in the metal products industry. The growth trends over the period 1968-1975 suggest that at higher levels of industrial development, the demand for labor shifts toward branches of heavy manufacturing.

Along with changes in the composition of employment, there has been a marked change in the structure of production. Heavy manufacturing improved its share in world manufacturing value added from 59.3 percent in 1960 to 67.7 percent in 1976. This occurred in the developed market economies, and the trend was even more pronounced in the centrally planned economies. Developing countries also participated in this trend; the share of heavy manufacturing in manufacturing value added for the developing countries rose from 37.5 percent in 1960 to 50.4 percent in 1975 (associated with only a moderate increase in this sector's share in manufacturing employment from 22.8 percent to 28.2 percent). Heavy manufacturing in the developing countries is highly concentrated; 5 countries accounted for more than half the total employment in this sector.

The more rapid expansion of employment in heavy manufacturing than in light manufacturing seems to have resulted not only from an increased production of capital goods or durable consumer goods, but also from the growing tendency of some developing countries to process their own natural resources, especially non-renewable ones. This is a comparatively new area of manufacturing in the Third World, and mainly concerns petrochemicals, iron and steel, and fertilizers. The production lines in this area tend to be capital-intensive. The establishment or expansion of these industries is largely motivated by better terms of trade for processed goods than for raw materials. From the viewpoint of employment generation, a development strategy might be based on the answers to such questions as: What kind of linkages would the local processing of natural resources generate? What kinds of employment, skills and technology would be available? Would the local processing of natural resources be a more viable industrial strategy for full employment than the local manufacture of capital goods?

Direct labor coefficients of most of the resource-based industries are low, often close to the lowest in the economy. Thus, resource-based industries do not seem to generate much direct employment. The few exceptions are leather goods and some products of wood, cork and rubber, which are considered highly labor-intensive. The literature on resource-processing industries does not provide much data on their potential to generate direct employment, but a few examples can be quoted. In Jamaica, the capital/labor ratio in bauxite and alumina production taken together was estimated at $34,000 per person in 1960, compared with a ratio of $7,000 per person in sugar milling and of $1,000 to $6,000 per person in most other manufacturing activities. In Colombia, an investment of $100 million in petrochemicals manufacture resulted in the employment of only 2,500 persons in 1967; the same investment in labor-intensive branches would have provided jobs for 50,000 persons, or one sixth of the manufacturing labor force in Colombia. Moreover, the resource-based industries are associated with a high proportion of raw material cost and a low share of labor cost, especially in developing countries. Technological changes are therefore geared to achieve efficiency in the use of raw materials, and seem to require fixed proportions of labor and capital.

The case for extending the local processing of natural resources rests not so much on its direct effect, however, as on its indirect effect on employment through linkages to other sectors. Available estimates of direct and indirect employment coefficients do not provide conclusive evidence on long-term employment effects: for some countries the inclusion of indirect employment coefficients improves the relative ranking of a given industry, while in others the position does not change materially. The results are sensitive to particular circumstances, since calculation of the total employment coefficient is based on assumptions about responses in the form of investment in other branches which may or may not occur. An indiscriminate expansion of resource-based industries for the sake of processing raw materials is likely to have a negligible effect on unemployment and the labor market. But some of these industries may provide the opportunity to establish mutually supporting, economically viable production lines and subsidiary activities--an interrelated industrial complex. Little is known at present, however, about the requisite combination of industries for integration that would prove viable in developing countries with access to foreign markets, technology and finance.

## Social Objectives

Industrial development is indispensable for economic and social progress, and is a precondition for raising levels of income and employment in developing countries. And the data in Table 2 above suggest that industry has often increased employment at faster rates than other sectors. Doubts have been expressed in recent years, however, about its social value. Briefly, the criticism of industrialization in developing countries takes two main forms: (a) industrialization has not led to a reduction in unemployment nor to a decrease in inequality; and (b) industry has been developed to the neglect of other sectors of the economy, especially agriculture, so that growth is not harmonious. Furthermore, industrial production has too frequently been geared to satisfying the demands of upper income groups, with consequences detrimental to employment generation, the equitable distribution of income and social justice.

Industrialization contributes most to social development when industry produces goods at low prices for broad strata of the population to satisfy their need for food, clothing, shelter, health and education. Industry should create employment opportunities directly through the choice of appropriate product-mix and technology, and indirectly by providing inputs for the expansion of other sectors, such as agriculture, construction and essential services. Increased productive employment and higher incomes for the poor will change both the level and rate of growth of demand for basic consumer goods and public services. This shift in the composition of demand should induce a shift in the pattern of production towards goods that may be more suitable for production on a relatively small scale. This may tend in turn to generate higher levels of productive employment, to the extent that the new product mix is characterized by greater labor-intensity.

## Industrial Technologies

The technological basis for industrial development has recently been the subject of much study and discussion, especially in relation to income and employment generation and other issues arising in connection with social objectives. The focus has been on the choice of appropriate technologies and their development, transfer and adaptation. Quantitative measures to determine this choice have generally been expressed in terms of factor-intensity and productivity. An important aim is to reduce the capital-intensity of industrial technologies in the developing countries; but this may be constrained by fixed factor coefficients, or by distortions resulting from government policies, or this aim may be subordinated to other considerations.

The term "appropriate technology" for the developing countries is often thought to mean simple, labor-intensive technology, intermediate rather than advanced. This does not imply, however, that all advanced technologies, meaning mainly capital-intensive technologies transferred from the developed countries, are necessarily inappropriate. Such technologies may be appropriate in many cases, especially in some of the heavy industrial sectors. Social objectives other than economic efficiency and income growth are included in the concept of appropriate technology: employment generation, improved working conditions, provision of basic needs, and an equitable distribution of income are also involved. Appropriate technologies will differ from country to country depending on the differences in the weights given to these various factors.

In any case, appropriate technology involves much more than a choice of labor-capital proportions for a given process. Labor and capital are not homogeneous production factors; there are many types of capital goods, some serving just one function, but many having alternative functions. Skilled labor inputs are human capital; capital can also be thought of as embodying a past labor content. This implies that capital-intensive technologies may not create less employment than labor-intensive technologies when using capital goods with a high labor content. Furthermore, for a given capital-intensive technology the induced rate of savings may be higher than for an alternative labor-intensive technology, given higher marginal savings rates for corporate or government owners than for industrial workers and small enterprises. Factors such as scale, capacity utilization, and plant location also need to be evaluated. And indirect effects on the choice of technology, especially through the use of intermediate inputs, need to be considered. For instance, the cost in foreign exchange of imported inputs can be viewed , under equilibrium trade conditions, as creating a need for an equal amount of exports needed to pay for these imports. In turn such exports, which in terms of comparative advantage are likely to be relatively labor-intensive, would generate additional employment. Thus, indirectly, the employment effect of using imported inputs might be quite high.

From the point of view of output, appropriate technology also involves many choices, since technology and product alternatives are often closely linked. For example, in providing an appropriate internal transport system there may be a choice between rail and road, between luxury and simple cars, between cars and bicycles. For many manufactured goods, labor-intensive production providing goods meeting basic needs could be an alternative to capital-intensive production providing sophisticated goods to meet the demand of high income groups. Technological choice may also be influenced by differences in product quality. Technological choice is also linked through consumer demand to income distribution: if the rich consume more capital-intensive goods than the poor, a more equitable distribution of income may lead to increased demand for labor-intensive goods and greater employment.

Clearly, the assessment of appropriate technology is not an easy matter. Cost-benefit analysis and shadow pricing can help, but in many cases the number of relationships involved makes quantitative analysis difficult, especially when several activities are linked. Besides the difficulties of finding the right criterion for assessing appropriate technology (and those related to the interdependence of activities), the acquisition of information on alternative techniques often presents problems. Such information is often only found through laborious research, and the cost of this may be quite high.

A consistent approach to the choice of technology. A comprehensive approach to the choice of industrial technology entails seeking and organizing technological and economic information in such a way that an evaluation can be made of the techniques available. It is possible to devise a scheme of investigation and to determine the least-cost technology in particular industrial processes. Thus, in each industry to be considered the objective is to identify a range of techniques that are expected to be economically efficient in the environment of developing countries. The choice ideally should be extended to include various mixes of different sub-processes to meet a diversity of needs.

This may be formally illustrated. A production process, in general, consists of a number of separate, identifiable operations or sub-processes, and each of these sub-processes may be performed by different methods or "sub-techniques." In the brewing of beer, the intake of raw materials, fermentation, and beer filtration would be examples of separate sub-processes that can be carried out by different sub-techniques. All of these sub-processes in the right sequence make up the production process, and a combination of them forms a complete technique for that process.

Suppose that the production of a certain commodity on a certain scale can be arranged by using two distinct techniques that are observed to be in use. Each production process consists of three separate sub-processes, A, B and C, so that both the two observed techniques consist of three sub-techniques. These two techniques with their sub-techniques may be represented as follows: $A_1$-$B_1$-$C_1$ and $A_2$-$B_2$-$C_2$. If it is assumed that the sub-processes are separate and distinct, the total number of techniques actually available is greater than the number of techniques observed to be in use. In this example, the total number of techniques is eight--two of which are the observed ones and six of which are synthetic in the sense that they are put together by mixing the sub-techniques that have been observed. For instance, $A_1$-$B_1$-$C_2$ is one synthetic technique; $A_1$-$B_2$-$C_1$ is another. It is necessary to have some way of making the technical and economic data pertaining to these alternative technologies commensurate so that they can be compared. This can be done by using the discounted-cash-flow methods of obtaining new present values for each of the alternative technologies. The procedure is then akin to that of project appraisal--except that it requires the meticulous and complete evaluation of a large number of alternative technologies.

The methodology described has been applied to identify the scope for the choice of industrial technologies in 12 industries: footwear, brewing, maize milling, iron foundry, sugar, leather tanning, fertilizer, cotton cloth, bricks, machine tools, bolts and nuts, and corrugated paper board. Some results of these studies may be summarized briefly:

(a) A significant range of technically efficient technologies exist in virtually all industries studied.

(b) In some cases--footwear, sugar (in some circumstances), leather tanning and brick-making--the optimal technology in specified environments of developing countries was also a labor-intensive technology, even when the evaluation was made using market prices.

(c) In most of the studies an examination of the variations in profitability among technologies, and the corresponding variations in employment and investment costs, showed that the variations in profitability were much narrower than those in employment and investment costs. An important implication of this finding is that insofar as there is a conflict between employment and profitability, the economic penalty for choosing the employment-generating technology would not seem to be very great.

(d) Even in a very capital-intensive industry, such as the fertilizer industry in the production of ammonia and urea, employment possibilities can be related to using marginally less capital-intensive methods and thus freeing investible funds which, in principle, could be deployed to provide additional employment in other activities.

A few of these studies are examined here to highlight important findings. In the study of footwear, considerable attention was given to the design of a factory capable of producing 300,000 pairs of men's shoes per annum. These shoes had leather uppers and cemented-on synthetic unit soles. In considering the factory design, 48 individual processes (work stations) were identified; at each station, where possible, a machine-intensive and a manual-intensive process was identified together with a process of intermediate intensity. By grouping the work stations according to stages of production, the number of separately identified technologies came to 486. By the use of the prices of 1972 in Ghana, an economic evaluation of the 486 technologies established that, at discount rates of both 10 and 20 percent, the least-cost technology would fall between the most machine-intensive and the most manual-intensive technologies, but would be nearer the latter in terms of investment requirements and employment. Although the variations in capital and labor inputs ranged down to 49 percent of the investment required for the most machine-intensive process, and up to 141 percent of the labor force required for the most capital-intensive set of operations at the labor-intensive end of the scale, there were no fewer than 430 technologies for which the net present value (at 10 percent) was within 2 percent of that associated with the most profitable technology. Moreover, the most manual-intensive technology was included in this number. When the discount rate was 20 percent a similarly high proportion of the technologies also had a net present value that fell within 2 percent of that of the most profitable.

The production of ammonia and urea was deliberately included in the studies in the hope that light could be thrown on the possibilities for factor substitution in a generically capital-intensive industry. The evaluation of relevant technologies concentrated largely on modern, highly capital-intensive technologies and Indian conditions in the early 1970s. It is worth noting that even here the variation in investment requirements across technologies was greater than that in profitability. Thus, an examination of 11 technologies, ranged in ascending order of fixed capital per process labor, suggested that the tenth would be the most profitable at discount rates of 10 and

20 percent in the production of urea in Indian conditions. None of the technologies would offer much employment. The fourth technology would, however, cause the investment cost to decline by some 13 percent compared with the tenth, but profits were only 6 and 3 percent less at discount rates of 10 and 20 percent respectively. As the difference in capital in the respective capital-labor ratios was more than ƀ 7,000 per man, it might be desirable to use a somewhat less capital-intensive method of producing urea and to use the investible funds thus saved elsewhere to provide additional employment.

In a footwear study a comparison was made, in Ethiopia, of the respective economic merits of producing 1.8 million pairs of men's shoes per annum: (a) by a single enterprise which, by producing 7,200 pairs of shoes per day could satisfy the entire requirement; (b) by 6 enterprises, each producing 1,200 pairs per day; (c) by 36 enterprises, each producing 200 pairs per day; and (d) by 1,200 enterprises, each producing 6 pairs per day. At both market and social prices the economic superiority of the single large factory was quite pronounced. The introduction of wider social considerations than those normally included in social cost-benefit analysis would make the establishment of 6 enterprises at different locations in the country a possibility, but the economic performance of the smaller enterprises would make it difficult to justify their establishment in any circumstances.

A similar comparison between factories of different size designed for African conditions to produce 28 million square yards of cotton cloth per annum had a broadly similar result: the economic advantage seemed to lie substantially with the modern technology. Taken together, the sugar, footwear and textile studies do not rule out intermediate technologies. They do, however, stress the importance of a careful and comprehensive consideration of alternatives; the failure to give the alternatives proper attention vitiates much of the recent work on appropriate technology.

The study on footwear illustrates another, frequently raised question. It is often suggested that technology is specially sensitive to the requirements of export markets, and that in particular production for export necessarily means the use of sophisticated technology. An examination of Ethiopian and Ghanaian footwear production and of the British market for imported footwear suggests that this is not universally so. For a well-specified product--men's leather-upper, cemented-on sole shoes--it was shown that the use of technology appropriate to the United Kingdom market in Ethiopia and Ghana would make it possible for these countries (at least in the conditions that prevailed in the early 1970s) to produce shoes that would be competitive with British production, even when allowance was made for transport costs. It was shown further that if the technologies chosen were appropriate to Ghana and Ethiopia, the price competitiveness of Ghanaian and Ethiopian shoes in the British market would be somewhat increased.

The studies discussed can be distinguished from most of the literature on appropriate technology by the logical rigor with which they have been conducted. Much of this literature is characterized by more or less technical description--this is particularly true of technologies that are thought to be appropriate in some broad sense for the rural areas--and frequently by the complete absence of serious economic evaluation, either at market or social prices. More recently, the range of considerations has widened to include the environment. A number of interesting, additional dimensions have emerged as a consequence, including attempts to define environmentally sound and economically appropriate technologies, and the consideration of such questions as whether the cost of "purifying" alternative technologies significantly affects the rank ordering of technologies from what it would be if environmental considerations were ignored.

## Rural Industry

Rural industries have advantages for national development with respect to their use of less expensive technology or machinery per unit of output, and per unit of labor. Rural areas offer less costly land (20 to 50 percent of urban land costs), buildings (50 to 75 percent of urban construction costs and less stringent building regulations), and often waste-disposal systems. Rural areas also can sustain the use of lower levels of technology if the production is geared to the less sophisticated needs of large rural masses. The development of rural industries would also be a more direct approach than reliance on the trickle-down effects of growth to reach the rural masses who represent the great majority of the poor.

Experience in the promotion of rural industrialization has been limited, however, and not all efforts have been successful. Among the difficulties encountered have been: 1.) The unresponsive nature of government administrative structures. Government ministries are organized along sectoral lines and they are geared largely to the conventional pattern of development in the industrial sector. Administrative structures and authority are not sufficiently decentralized in a number of countries. 2.) Inadequate allocation of resources by Governments to carry forward integrated rural development programs: rural industries require the simultaneous development of other sectors of the rural economy. 3.) Rural industrialization needs to be integrated with rural development programs, on the one hand, but also with national industrial development programs, on the other. Techniques of regional and area planning are most likely to help in achieving integration. Such techniques are also used in rural spatial planning. The identification of growth centers where adequate infrastructure has developed, or is being planned, would greatly enhance the effectiveness and viability of rural industries. However, regional or area planning is still in its infancy in most developing countries.

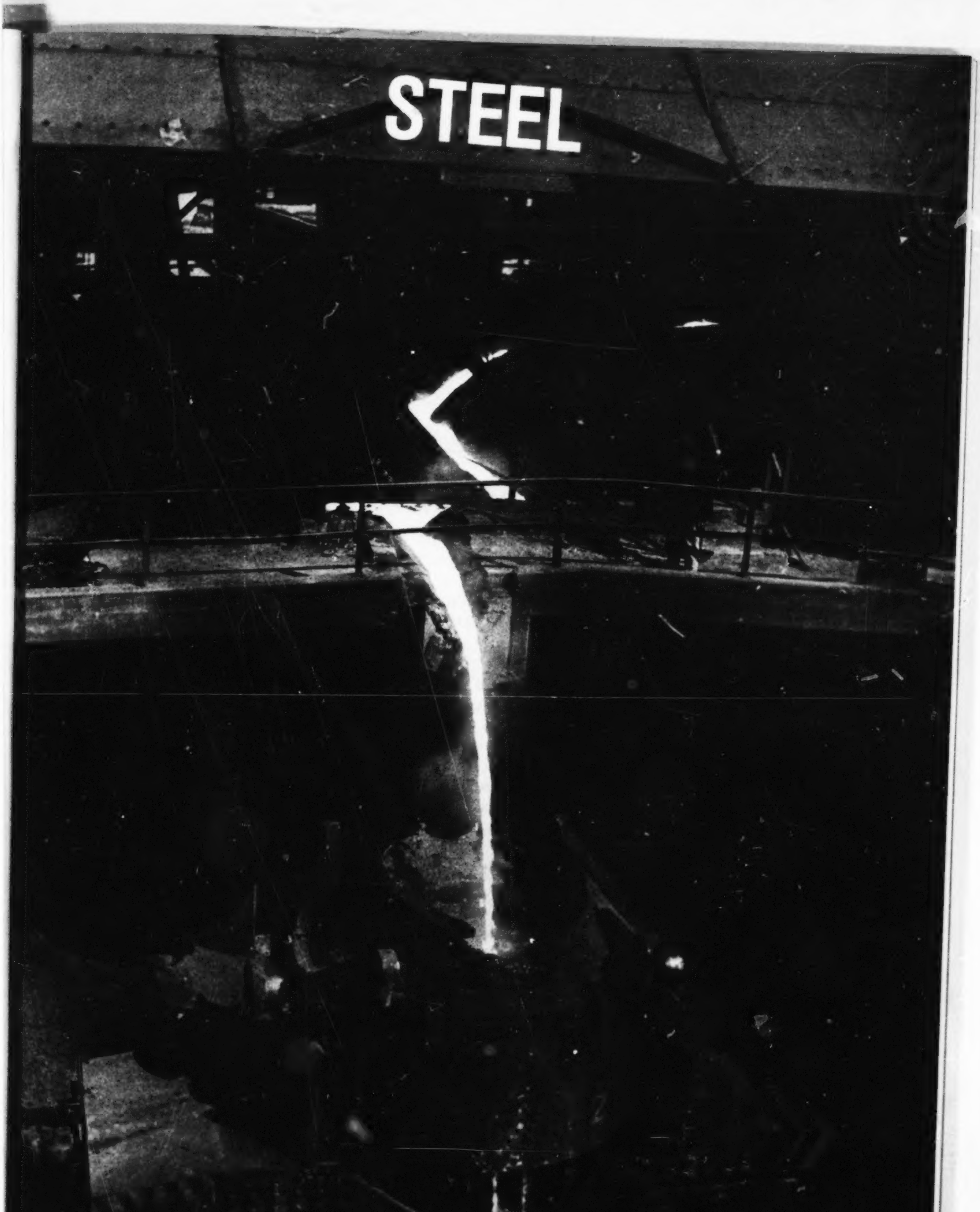
Added to these problems is that of understanding the nature of rural industrialization. A too narrow interpretation has often led to the promotion of only village crafts, or industries and services to achieve village-by-village self-sufficiency. This in itself will not achieve the objectives of employment promotion and income redistribution. Options should be kept open for a variety of sizes and technological levels of industrial enterprises to be located in rural areas. The reason for such a limited program may be that Governments have tended to see rural industrialization as a question of large versus small-scale enterprises. The possibilities that a variety of industries can be located in rural areas, and that technological dualism may be healthy, do not seem to be recognized.

Programs of rural industrial development now in operation in different countries fall into three categories: (a) Those that are nation-wide and cover rural areas in all or most provinces of the country, as e.g. in India, Iran, Kenya, Malaysia and the United Republic of Tanzania; (b) those that are experimental or pilot in approach and that cover a few selected areas, regions or provinces, as in Mexico; and (c) those that form part of the effort to promote small-scale industries and handicrafts. These are located mainly in rural areas, but development efforts should not be biased in favor of rural areas (e.g. in Bangladesh, Nepal and Pakistan).

Ingrained in all rural development programs is undoubtedly the aim of bringing the benefits of urban life (education and health services, cultural and social activities, and representative institutions) to rural residents. However, most integrated rural development programs do not as yet include spatial planning, and they are not fully integrated with regional planning efforts. Such an approach would entail a concept of rural-urban continuums, in which each stratum of locality would have a particular role to play in industrialization. The upgrading and integration of local factor endowments at each stratum in order to approach urban levels would help the industrialization process. There appears to be a growing interest in planning industries on the basis of rural-urban continuums. In the present industrial structure of China, large-scale industries operate in cities such as Shanghai and Canton, and medium-scale enterprises operate in almost all cities. In addition, there are numerous small rural commune industries and small urban cooperative industrial enterprises. Its training systems, its R and D and diffusion systems, and its industrial planning mechanisms take fully into account the contributions of industry at each level.

India is emphasizing a block-by-block planning effort in its Sixth National Development Plan (1977-82) for about 5,000 development blocks, each of which covers an average of 100 villages and several levels of localities in a rural-urban continuum. At the national level, this approach will emphasize area planning for the first time as distinct from sectoral planning. Pakistan, in its rural development program has developed two levels of concentration, primary units at a "homogeneous community" level, and the markaz (with a service area of 50 to 60 villages) where agro-based industries, machine workshops etc. are located. There were about 138 such markaz in 1977, and a total of 625 to cover 45,000 villages is planned in the future. Kenya has a rural industrial development program that involves the establishment of development centers for rural industries; 21 of these are planned. This program will become the base for assisting industry in small centers through extension activities. In Mexico the pilot experience of one state (Jalisco) shows a similar trend; there attention is given to three levels. The first level is in the city of Tuxpan where larger, concentrated workshops have been established averaging 32 workers each, with an investment of 50,000 pesos per worker. The second level includes the small towns of Copala, Tonila, San Jose de la Tinaja, where attention is given to production to meet local needs (cheese, brown sugar, sausages, bread, shirts, sweaters etc.). The third level is in the small villages, particularly where unemployment is felt most.

[Extracted from Chapters 7 and 8, World Industry Since 1960: Progress and Prospects, United Nations Industrial Development Organization, New York, 1979. U.N. Sales Number E.79.II.B.3.]


STEEL

HOT MELTED STEEL FLOWS FROM FURNACES OF THE VOLTA REDONDA MILL IN RIO DE JANEIRO, BRAZIL. (PHOTO: USIS RIO DE JANEIRO.) STEEL OUTPUT IS ON THE INCREASE IN THE THIRD WORLD, AS IS SHOWN BY THE FOLLOWING FIGURES FOR THE DEVELOPING COUNTRIES FOR 1960 TO 1977, AND THE ESTIMATES OF FUTURE CAPACITY.

## Steel Trends in Developing Countries

| 1960 | Steel Capacity* (Thousand Metric Tons) | Steel Production* (Thousand Metric Tons) | Share of Consumption (Percent) | Net Steel Imports* (Thousand Metric Tons) | Apparent Consumption (Thousand Metric Tons) |
|---|---|---|---|---|---|
| 1960 | 10,000 | 8.700 | 41.4 | 12,300 | 21,000 |
| 1965 | 20,000 | 16,100 | 50.2 | 16,000 | 32,100 |
| 1970 | 28,000 | 21,600 | 53.2 | 19,000 | 40,600 |
| 1977 | 58,000 | 41,700 | 60.9 | 26,800 | 68,500 |

*Excludes mainland China

## Crude Steelmaking Capacity, Year End
(Million Metric Tons)

| | Estimated 1978 | Projected 1980 | 1985 |
|---|---|---|---|
| Total | 64.0 | 75.9 | 112.0 |
| Latin America | 30.5 | 36.5 | 56.0 |
| Brazil | 14.0 | 15.0 | 25.0 |
| Mexico | 9.0 | 10.0 | 13.5 |
| Venezuela | 1.5 | 4.0 | 6.5 |
| Argentina | 4.0 | 5.0 | 7.0 |
| Other | 2.0 | 2.5 | 4.0 |
| Africa | 1.7 | 3.0 | 7.0 |
| Algeria | 0.6 | 1.0 | 2.0 |
| Other | 1.1 | 2.0 | 5.0 |
| Middle East | 4.6 | 4.7 | 7.2 |
| Iran | 2.0 | 2.0 | 2.0 |
| Egypt | 1.8 | 1.8 | 2.2 |
| Saudi Arabia | NEGL | NEGL | 1.6 |
| Other | 0.8 | 0.9 | 1.4 |
| Asia* | 27.2 | 31.7 | 41.8 |
| India | 13.5 | 14.3 | 19.0 |
| South Korea | 7.3 | 8.0 | 10.5 |
| Taiwan | 4.0 | 5.0 | 7.0 |
| Indonesia | 1.0 | 2.0 | 2.0 |
| Other | 1.4 | 2.4 | 3.3 |

*Excludes Japan and China

Estimates of the National Foreign Assessment Center, as of July 1979.

# An Engineering-Economic and Manpower Analysis for a Steel Plant In Nigeria

Okuwese Ozoro

[The undertaking of an integrated iron and steel industry in a country where there has been none requires careful planning for its success. A Nigerian discusses some of the considerations involved for his country--size of plant, maintenance, and especially the advance training of skilled personnel.]

The Nigerian government has made a policy decision that, considering the expected growth of the economy and cost of imports and other vital national interests, it is in the overall interest of the country to build an integrated iron and steel plant in Nigeria. The decision raises many questions that touch on the problems of public investment in a developing country. Is the country well advised to undertake the necessarily vast capital investment? Is the raw material base adequate to establish the industry and, if not, how would the importation of raw materials to operate a steel industry compare with the import of finished steel products? It takes several years to plan and establish a steel industry; hence, the size of plant chosen now may be outgrown by demand before it is fully operational. How, therefore, is the demand expected to grow over a reasonably long period in the future, and what capacity of plant would be optimal in meeting that demand? Assuming that a plant of a certain capacity has been chosen in accordance with estimated demand, where should it be located, and why? What problems are raised by choice of technology, and by the ways of providing skilled manpower for the operation of a projected plant? These are some of the questions that must be answered, or at least studied with a

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view to finding some of the answers, to justify a very large public investment of the cost required for an integrated iron and steel complex.

Since Nigeria presently has no iron and steel industry, the manpower requirement of such a plant has been estimated by "international analogy", as UNIDO calls it. That is, the manpower patterns of other countries have been studied on the assumption that the type and quantity of skills that would be needed in the Nigerian plant do not differ substantially. While data derived through international comparison may not be completely applicable in a given development setting, they can at least provide reference points for the guidance of manpower planners. Many projects are undertaken in developing countries without adequate prior knowledge of the type and quantities of skills required, and of how those skills are to be phased in with the project. This has very often meant that thousands, even millions of dollars worth of scarce capital equipment either cannot yield adequate returns or is totally wasted; skilled manpower is frequently an even greater bottleneck to production than capital or materials shortages.

[Editorial Note: The original study is a carefully composed, highly integrated presentation which cannot be conveyed in these excerpts. What follows is a sampling of topics of potential interest.]

## Nigeria's Probable Steel Demand in 1985

Typically, a modern steel plant takes about five years to construct in a developing country, and 3-5 more years to achieve full capacity production. Thus, in designing the capacity of a steel plant begun in 1975, for example, it is necessary to estimate probable steel demand in 1985 and beyond.

Several forecasting techniques have been developed. For short- and medium-term forecasts, it is common to fit a linear curve to past data and extrapolate it forward. However, Nigeria is unlikely to follow a linear trend over a long forecast period, given the rapid pace of development that appears attainable. Alternatively, steel consumption can be related to a macro-economic variable such as GNP or GDP; some use multiple correlation to relate steel consumption to several economic variables such as industrial production, construction and gross capital formation. The main difficulty here is that the macro-economic variables are themselves inherently difficult to forecast over a long period of time, and given the inadequacies of macro-economic data for Nigeria this method can only produce very crude estimates. A simple version of this method will be used.

Two other methods are more practical. The first method is that of historical analogy. A more advanced country is selected which at some period in the past had attained a level of economic development similar to Nigeria's. The steel consumption of the more advanced country at a later stage of development is then imputed to Nigeria at a future date. For plausible results, both countries should be fairly similar geographically and economically. Second, steel demand may be estimated from "end-uses", by estimating the future growth in each of the economic sectors consuming steel and their steel requirements at a given date. Then a total figure for the economy is calculated. In Nigeria's case, where patterns of steel consumption are not well established, the growth rates in the steel-using sectors are difficult to estimate, and a little crystal gazing is inevitable.

In 1970 Nigeria's direct steel consumption according to U.N. statistics was 466,000 tons. Assuming that steel consumption approximately doubles in every eight years in most developing countries, a rough estimate could be obtained for several years ahead. This trend is reasonably confirmed for Nigeria's imports since independence. On this basis the following pattern of direct steel consumption may be expected:

1970 -- 466,000 tons
1978 -- 932,000 tons
1986 -- 1,864,000 tons

Assuming that 80% of direct steel consumption should be domestically produced, a plant capacity of about 1,500,000 tons rolled steel would be required.

Brazil is a country which has passed a state of development that Nigeria may reasonably be expected to attain in 1985, and which has fairly close similarities. Both grow the same range of tropical crops--cocoa, cotton, rubber, coffee, palm products, ground nuts, etc.--and both are major exporters of some of them. Brazil is a larger country and has more known mineral resources, especially high grade iron ore; but to balance this, Nigeria produces and exports far more high grade crude oil. In 1971-72 Brazil's economy grew at about 11% while Nigeria's grew at about 12%.

Assuming the population of Nigeria in 1970 to be about 60 million and growing at 2.3%, it may be expected that Nigeria's population in 1985 would be about 84 million, which is very close to Brazil's population in 1965. Nigeria's GDP in 1971-72 was about N3,107 million, i.e., about $9,231 million. If an annual growth rate of about 8% up to 1985 is assumed, the GDP in that year should be about $25,350 million; and assuming 95% of the GDP is GNP, then Nigeria's GNP in 1985 is about $24,000 million. This is very close to Brazil's GNP in 1965. On the basis of these similarities, one may impute Nigeria's probable steel consumption in 1985 as 3,082,496 ingot tons, (i.e., about 2,400,000 tons of rolled products).

| Brazil, 1965 | Nigeria, 1985 |
|---|---|
| Population: 82,200,000 | 84 million |
| GNP: $25,900 million | $24,000 million |
| Per Capita GNP: $308 | $277 |
| Total Steel Consumption, Ingot Tons: 3,200,000 | 3,082,496 tons |
| Per Capita Steel Consumption: 44 kg | 37 kg |

An empirical study by the United Nations Economic Commission for Africa related steel consumption to GDP and gross capital formation. If $S$ is steel consumption, and $p$ the proportion of GDP in gross capital formation, then $S$ in kg is given by

$$S = GDP\ (0.06 + 0.03p)$$

where GDP is in U.S. dollars. Assuming Nigeria's GDP in 1985 as estimated above, i.e., $25,350 million, and suppose $p = 0.20$, then $S = 3,040,000$ metric tons of total steel consumption, of which 2/3 may be taken as direct steel consumption, i.e., 2,006,400 tons. Domestic production of 80% of direct steel consumption would require a plant capacity of about 1,600,000 tons.

The grand total by direct estimation of end-uses of steel in each sector of the economy [details omitted here] comes to 1,598,265 tons. An alternative way to estimate probable demand by end-uses is to look at the probable capital investment pattern in economic sectors by 1985, and to calculate the steel content by assuming 0.36 kg per U.S. dollar of capital investment. The total estimated in this way is 2,540,000 metric tons.

Summary of Estimates

| | | |
|---|---|---|
| (1) | By eight year growth pattern: | 1,864,000 metric tons |
| (2) | By analogy with Brazil: | 2,438,000 " " |
| (3) | By gross domestic product: | 2,006,000 " " |
| (4) | Direct estimation by end-uses: | 1,598,265 " " |
| (5) | Estimate by probable capital investments: | 1,676,400 " " |

These estimates indicate that by 1985 Nigerian consumption of rolled steel should be in the range of 1.5-2.5 million tons.

Strategy for Phased Development. The choice of plant size is a complicated question. i) Under-utilization of capacity in a plant which is too large can result in very high production costs.

ii) But if a plant is too small for its market, the cost of building additional capacity later to meet an increased demand will be more expensive than if excess capacity had been built into the initial plant size. iii) There are considerable economies of scale in steelmaking processes which favor larger plants. iv) But these are offset by the difficulties of learning new techniques; a developing country just beginning to establish a steel industry would be well advised to consider starting small.

In view of these considerations, one has to strike a balance of some sort. A phased development would appear to be the best strategy. The development is envisaged in three phases as follows: 1.) Start with a plant of one million tons of rolled products, with a built-in excess capacity in the more expensive units such as the rolling mills for items that are heaviest in demand. The items in heaviest import demand have been sections, bars, rods and other structural products, tubes and sheets. 2.) In phase two, one or two things may happen. It may be necessary to expand iron and steelmaking capacity so as to utilize fully the rolling mill capacity if demand for existing rolled products grows rapidly. It may also be necessary to install new product lines and thereby raise the overall capacity to about 2.5 million tons or more. At this stage, the size of the expansion will depend on whether it is judged to be in the overall interest of the economy to concentrate all major steel production in one large plant or to distribute it between various industrial centers. Of course, it is always possible to have small electric furnace steelmaking plants very close to market centers wherever feasible. Such small plants will be required for special steels, such as stainless and tool steels, or steels for special machine components. 3.) A final phase of expansion should probably exhaust the capacity of the site, considering the desireability or otherwise of distributing major steel-producing units throughout the economy.

Therefore, planning and further analysis are based on a plant capacity of 1 million tons of rolled products. This would require about 1,050,000 tons of crude steel assuming continuous casting is used in place of the traditional blooming mill. The one million tons of rolled products may be distributed as follows:

Blooms - Medium sections - 150,000 tons
Billets - Bars, wire rods, torsteel, etc. - 300,000 tons
Slabs - Plates and skelp for tubes - 250,000 tons
Sheets - Plain and galvanized - 300,000 tons

## The Organization of Maintenance

The proper maintenance of equipment in a steel plant is a vital vunction, and it is one which affects the manpower requirements very considerably. Generally, an integrated steel plant in

Nigeria must provide all its own maintenance services. An essential function of maintenance is to replace or repair worn out components. Now, to carry all components necessary for maintenance entails a very large inventory and accurate inventory control. Quite often the foreign exchange for purchase of needed parts is not available reliably, or on time, in a developing country. One alternative is to manufacture as many components as possible. As a rule, the raw materials such as alloy steels, forged steel bars, etc. from which many components are made are relatively cheap, unlike the finished items. Furthermore, the experience of actually manufacturing spare parts provides excellent training in various technological processes. The alternative of making as many spare parts as possible is recommended. This choice clearly affects the manpower requirement in a very profound manner, because of the highly skilled jobs that would be entailed.

But how is the actual maintenance organized? Should there be one central maintenance organization with satellite units serving various departments, or several independent maintenance shops for each of the major sections of an integrated steel plant? What is to be the organizational structure for manning the system? It is important whether for any chosen structure there is to be a maintenance geared to repairs after failure, or designed to prevent failure as much as possible while able to effect repairs to any failures that may occur as rapidly as possible.

The following maintenance structure is proposed. There should be two central workshops, mechanical and electrical, equipped to undertake all major repairs for the entire steel plant. That is, major items of repair should be sent to the appropriate workshop which should be equipped to manufacture as many items as possible. In addition to these two central workshops, very important units such as the rolling mills, blast furnace, coke ovens and by-product plants should have small workshops attached to them to undertake routine production maintenance. This production maintenance occurs in every shift, and deals with all jobs that are of such a minor nature that they can be done quickly, so that work is interrupted at minimum cost if at all.

The overall philosophy should be preventive maintenance. This means that a detailed long-range plan is made such that certain stipulated overhauls of differing extent are undertaken at pre-assigned periods, but such that production is interrupted as little as possible. The long range plan can cover as long as three years; the maintenance work goes on every day, week and month of the period covered. Such an arrangement requires very careful planning, supervision and coordination at all levels of the enterprise. The trouble is well worthwhile for a developing country which must keep its huge capital investment in machinery operating at maximum efficiency in order to achieve best returns.

There are many odds against such an achievement, and strenuous effort to prevent expensive machines from becoming idle is one of the surest ways to fight these odds. One of the tragedies of development is the almost careless attitude to making scarce capital yield adequate returns. Eroding soils, stalled trucks, leaking roofs, prematurely run-down machines, unsafe bridges, clogged-up irrigation ditches--all testify to the same pervasive and paradoxical trait: the inadequate care for existing capital in capital-poor countries. As Hirschman observes, "For maintenance to be effective, people must be made to act as though it had to be undertaken at precise intervals, suppressing their better knowledge that deferment by a day, a week or a month may not matter; they must organize this fiction, submit to it, and set up a signalling system to enforce it."

## Overall Estimate of Manpower Needs

On the basis of Nigeria's demand for steel, it was decided that the country should produce 1 million tons of this expected demand for rolled products. The normal materials process wastage has been about 33%, but with continuous casting replacing soaking pits and blooming mill the wastage should be much less; about 95% efficiency of conversion is often quoted. On this basis a 1.05 million ton mill should should produce 1 million tons of rolled steel. A high assumption of labor productivity is made so as to keep the overall manpower low. This is done because the tendency in practice is for the number of men to grow, and if the plant starts with a low productivity target the trend will escalate the numbers. It is best to start with a minimum number of men so as to inculcate good working habits, and to increase personnel only after careful analysis of any demand for increased manning.

Assuming an overall labor productivity of 150 tons per man year, for 1.05 million tons of crude steel the "in works" manpower would be 7,000 men. Allowing another 1,000 men for administration, the total would be about 8,000. For a developing country this is a small number, but it is really not too bad. In India it is readily admitted that with good planning the public sector plants could have been manned with 9,000 men "in works" at the 1 million tons stage instead of about 15,000 men which actually obtained in most of the plants. Indian manpower figures are high partly because of the practice of providing helpers to skilled workers--one to carry his tool box, and another to hold job pieces, and so on. This practise is not recommended. Usiminas in Brazil is producing 1 million tons of flats with 5,900 men.

The "in works" personnel are tentatively distributed as follows:

5% Engineers/Managers
15% Technicians
45% Skilled
25% Semi-skilled/General Labor
10% "In Works" Office Staff

The percentages suggested for engineers, technicians and skilled workers are rather high for two reasons: to allow for sophisticated processes, and to ensure that high caliber personnel are available to absorb skills at the initial stages of the plant.

It is estimated that the following types of engineers and scientists are required: Mechanical, Metallurgical, Electrical, Chemical, Ceramic, Instrument, Fuel, Lubrication, Industrial/Production, Civil/Structures and Chemists. Nigeria now educates only Mechanical, Electrical and Civil Engineers; the other types will have to start training right away. After the engineers, the technicians are college diploma holders in various engineering fields. Some of the operatives are highly skilled men trained on the job, e.g., rollers, assistant rollers, and blowers. The largest single group of workers are the skilled men who are responsible for repairs and maintenance of machinery and equipment. The major skills are: fitters/machinists, electricians, blacksmiths, pattern amkers, core molders, tool and die makers, plumbers, welders/gas cutters, etc.

## Time-Phasing of the Manpower Requirements

It is apparent that these various skills cannot all be recruited, trained and deployed at one point in time. The question, therefore, arises as to how these men are to be made available. This clearly involves the construction program of the plant and the commissioning sequence of the various plant units. The construction of modern large-scale industrial projects is a complex affair; in fact, so complex that special techniques (e.g. CPM and PERT) have been developed for planning construction sequences. What follows is a rough estimate to indicate how an actual program might look.

The construction sequences of an integrated steel plant could be done in several ways. For instance, it may be thought desirable to construct the whole plant so that units are commissioned within a few months or weeks of each other. This is usually the case when it is intended that the plant should supply all the inputs to its various units within itself, especially where reheating furnaces in the rolling mills have to be fuelled by coke-oven gas. In this situation, the coke ovens and blast furnaces are commissioned before the rolling mills. Another sequence is often called backward integration, which can be very piecemeal indeed. The long-range backward integration starts with rolling mills, which can start operation several years in advance of other units such as coke ovens, blast furnaces, ore and coal-handling facilities, etc. But Nigeria is in a hurry, and the estimate is that the whole construction program should not take more than five years; it might be three years. The suggested construction sequence for the production units, then, starts with the rolling mills on the assumption that the plant location is to be near a gas field. The mills could be commissioned several months ahead of the blast furnaces and coke ovens since blooms, billets and slabs could be imported, reheated with natural gas and rolled to serve urgent needs of the economy, while the other units can be programmed to start all at once several months later.

The major advantage of the staggered rather than a simultaneous construction and commissioning sequence is really to stagger the demand for manpower so that their supply and training can be phased, with a consequent reduction of manpower bottlenecks. Hence, the construction chart is a valuable guide as to how the manpower system might be phased with construction schedules and commissioning of the units. When a plant unit is commissioned, half of the overall labor force should be in position. During the first six months they will be oriented and/or trained in a series of what might be called "dry runs" before actual round-the-clock production operation begins. The manning should remain at this level until the unit is producing at about or slightly above half capacity. It is estimated that this should occur at about 18 months from start-up. At this stage, the labor force should be increased to three quarters of its full strength, and again to remain there until the plant unit achieves about three quarters of its full capacity. The final one quarter of the labor force should be very slowly filled in. This procedure is to avoid unnecessary overmanning and resulting indiscipline and sloppy work habits. The result of the above phasing operations can be shown in charts indicating the distribution of engineers and technicians by plant units or departments through time, while another chart shows the corresponding distribution of craftsmen [omitted].

## Managerial and Supervisory Training

Technical competence is the first major consideration. It is essential to select men who are educated and if possible have practiced the technologies associated with a steel plant. This is hard to fulfill in a country without prior steelmaking facilities. There are a few Nigerians working abroad in steel plants, but even if they can be persuaded to return home their numbers are insufficient.

There are two ways to tackle the problem: In such fields as mechanical, electrical and civil engineering where there are quite a few Nigerians in practice, either in government or industry, suitable inducement could be offered to attract them into the steel plant. Such persons should after selection be sent abroad to acquire experience in the operation of a steel plant, especially in technologies to be employed in the proposed plant. They should first be exposed to the whole range of processes in a steel plant to acquaint them with the interconnected nature of steelmaking in an integrated plant; thereafter they should concentrate on some chosen aspect such as the LD process or rolling mills. Such training can be arranged with the technical partners in the steel project or through governments of appropriate friendly countries. On the other hand, in areas where there are extremely few Nigerians already qualified such as metallurgy and chemical engineering, a crash program should be initiated without delay to send young persons abroad to acquire basic technological education, to be followed by the sort of practical training outlined above.

The above program applies with equal force to supervisors as well as managers, with special emphasis on the particular responsibilities at each level. The problem of recruiting practicing technicians in mechanical, electrical and civil engineering is likely to be much less than that of engineers, since all Nigerian polytechnics offer technician courses in these fields. But there are no courses available in the country in metallurgical and chemical engineering, at either engineer or technician level.

The first prerequisite in planning for management or supervisory staff is to define the duties of each post very carefully, and to assess whether individuals occupying or likely to occupy each post have the requisite qualities of character and training to discharge those duties. Training should then be designed to either inculcate or reinforce the necessary skills according to the degree of deficiencies determined from the assessment. Lest training should be enshrined as the only God of good management, however, it is necessary to make a caveat. While training is extremely important it cannot of itself create good managers. Good managers evolve both from the training processes we have outlined and from a sensitive awareness and appropriate reaction to social, political, psychological, economic and other factors which no training program can possibly cover. [Descriptions of the requirements for training scientist-technologists, technicians, craftsmen, and operatives follow.]

Necessity for a training center. It is, of course, possible to have a training organization which simply arranges courses in suitable institutions or sends trainees abroad. But the situation in which the proposed steel plant will initially find itself requires a fully equipped technical training center designed to offer courses for technicians and craftsmen. It should also be capable of organizing courses on a short-term basis in various management and supervisory functions. The necessity for such a center is clear from our analyses of the training requirements: some of the technical courses are not now being offered, and no other enterprise would have the incentive to initiate training in some of them, e.g., the foundry trades. The steel plant will have to have a fully equipped school to operate these courses.

The technical training center should be erected as soon as the location of the steel plant is known. In my discussions with top management both in India and Brazil, it was pointed out that a common and sad mistake is to wait for several years after the plant is in operation before establishing a training center. The best policy is to have a fully equipped and staffed technical training center in operation at least three years before the steel plant goes on stream. It can then be used to train staff at the stage when such training is most critical. This has not been usual, and most experienced managers of steel plants in the countries visited regret a curious lack of vision on the part of planners towards this problem. All too often action is taken only when collapse is threatened by the lack of trained persons in various skills at the critical stages of establishing the steel plant. We strongly recommend that Nigeria should learn from the experience of other countries.

[Extracted from "An Engineering-Economic Analysis and Manpower Planning for Establishing an Integrated Iron and Steel Plant in Nigeria," Chapters 1,2,4,7 and 11, PhD Dissertation in Engineering-Economic Systems, Stanford University, Palo Alto, California, 1974.]

Note: Since the above was written, Nigeria has embarked on the construction of a steel industry. The steel journal, Metal Bulletin of Sept. 18, 1979 reports that plans are well underway for two large integrated mills. A blast furnace-based plant at Ajaokuta, with initial 1.3 million tons per year capacity, is due to start up in 1986, and may be expanded to 5 million tons by 1990. A direct reduction-based works at Warri will be commissioned in 1981 with 1 million tons a year capacity, which could later reach 3 million. Billets from these two plants will be sent to three inland re-rolling mills of over 200,000 tons capacity each. Meanwhile, Nigeria's consumption of imported products continues to rise, reaching 2.5 million tons in 1977.

# Toward Radical Changes in Steelmaking

**Julian Szekely**

[This article outlines briefly the current technology used for making iron, steel, and standard steel products. It then describes several areas where radical new technologies have been tested and show promise.]

## Current Steelmaking Technology: How it Works

There are five stages in conventional steel processing by which raw materials are converted to finished steel products:

- Raw materials preparation and cokemaking
- Ironmaking
- Steelmaking
- Casting and primary rolling
- Finishing

It is customary to term the first four stages as the "primary end" and the last stage as the "finishing end." Consider each of these in turn.

Raw materials preparation processes convert the iron ores and the coking coal into forms suitable for ironmaking. The ores, essentially iron oxides containing some impurities, may be agglomerated into particles at least roughly the size of small marbles before they are introduced into blast furnaces. This is done either in pelletizing units (usually located at the mine site) or in sinterplants in which mixtures of fine ore particles, limestone, and other materials are made to undergo partial fusion.

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The coke, which serves both as a reducing agent and as a fuel in ironmaking, is manufactured from coal in coke ovens. Finely ground coal is heated in the absence of air to temperatures at which volatile matter, moisture, and some of the sulfur compounds are driven off. The result is metallurgical coke; the volatiles, known as coke oven gas, are also a valuable fuel.

Most ironmaking is done in iron blast furnaces, which are in essence tall vertical shafts up to 30 meters high and 10 to 15 meters in diameter. Iron in ore, sinter or pellets, flux (limestone), and metallurgical coke are charged (i.e. put in) at the top, while preheated air is blown into the system at the bottom. There is partial combustion of the coke, and the oxygen and minerals are removed from the iron ores, reducing them to metallic iron, during their descent through the furnace. The main products are molten iron (containing carbon, silicon, manganese, sulfur, and phosphorus), molten slag (waste material), and blast furnace offgas. Typically, a single such blast furnace produces some 1,000 to 10,000 tons of molten iron per day.

An alternative to the blast furnace, especially suitable for small-scale operations and where oil or natural gas are plentiful, is provided by "direct-reduction" processes. These are carried out in several types of furnaces in which iron ore pellets brought in contact with an ascending mixture of reducing gas in a counterflow arrangement. The product of direct reduction units is solid "sponge iron" which has to be melted and refined in electric arc furnaces to obtain steel. Typical direct reduction units produce some 1,000 tons per day. (At present less than 5 percent of the world's total ironmaking capacity is based on direct reduction.)

Steelmaking is the process of purifying the metal from the blast furnace or the direct reduction furnace--recycled steel scrap may also be used--by selectively oxidizing such impurities as carbon, silicon, manganese, sulfur, and phosphorus.

The open-hearth steelmaking process involves the treatment of hot metal and scrap in a shallow reverbatory furnace which is heated by burning oil or natural gas. The impurities are oxidized and withdrawn as slag and offgas. This is oldest of the currently used technologies, and it is rapidly fading in significance due to its high energy and labor requirements.

The dominant steelmaking operation at present is the basic oxygen process, in which molten iron and scrap are introduced into a pear-shaped vessel and then a supersonic oxygen jet is blown onto the bath surface. The oxygen reacts with the impurities to create slag and offgas, and the refining is completed in less than 25 minutes, in contrast to several hours in the open hearth process. A variant of the basic oxygen process is the Q-BOP operation, which involves blowing oxygen and a coolant through the bottom of the vessel instead of from above.

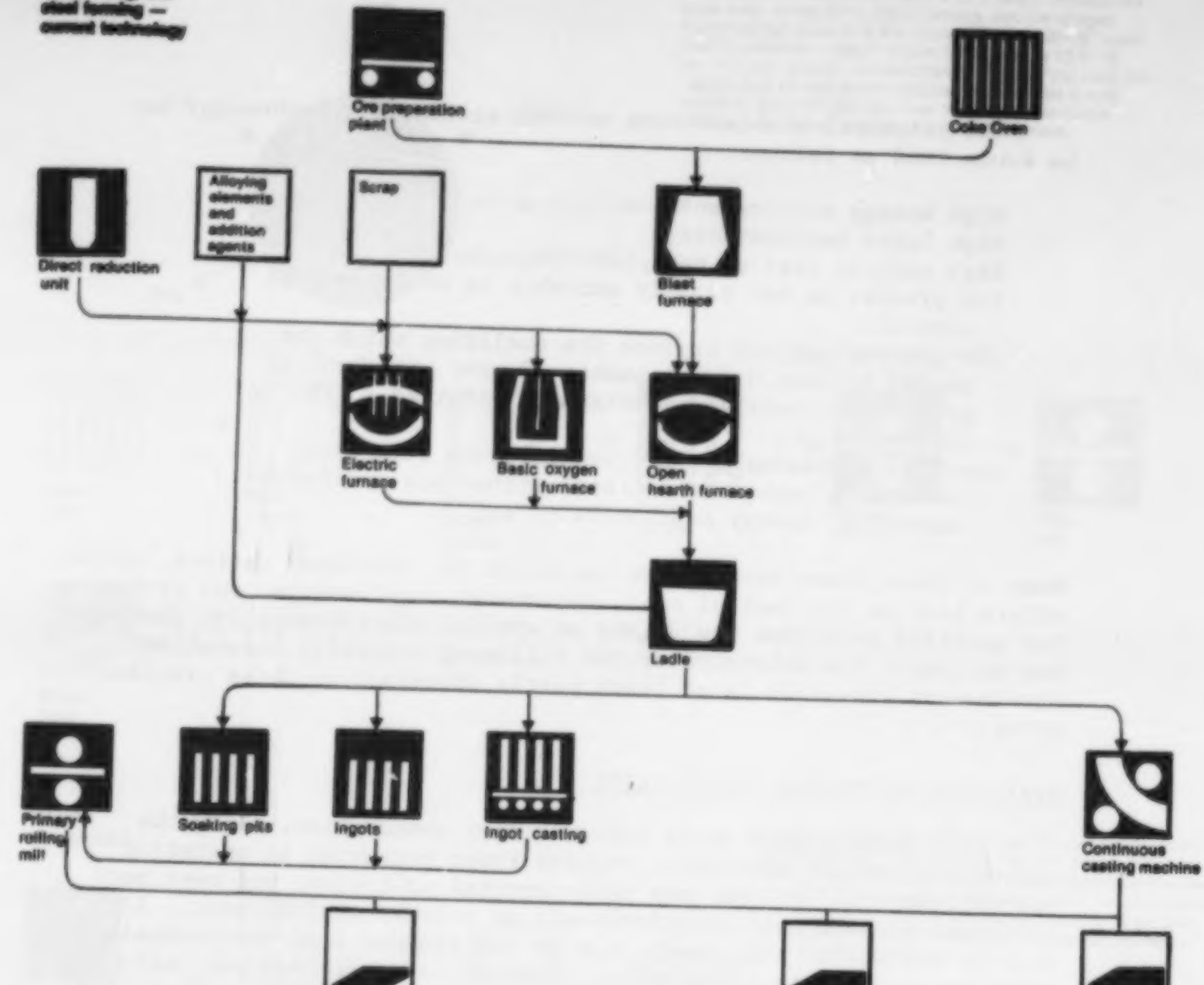
Steel is also made in electric furnaces, which are attractive because they can accept charges ranging from 100 percent scrap to largely molten hot metal. Such a furnace consists of a cylindrical shell with a dished bottom which is covered by a removable roof through which graphite electrodes are inserted. The arc struck between these electrodes and the metal charge provides the thermal energy needed to melt the charge, and the impurities are oxidized by an injected oxygen stream.

Casting and primary rolling are carried out immediately after the steelmaking is completed. In conventional mills, the steel is formed into ingots which are processed into blooms or slabs at a later time in the primary (rolling) mills. If continuous casting a much more energy-efficient operation) is used, slabs and billets are produced directly as the new steel emerges from the furnace. The slabs and blocks (called billets and blooms) thus produced are converted to the final products in finishing mills, where these intermediate products are brought to the proper temperature in reheating furnaces and are then rolled in several stages (hot and cold strip mills, bar mills, and the like) into the finished shapes.

A typical integrated steelplant, comprising all the processes described above, is a very complex operation. There are some 40 plants of this type in the U.S., ranging in capacity from about one to eight million tons per year of finished product. Total U.S. finished steel production is now about 100 million tons per year. The average cost of producing one ton of steel in a U.S. plant is about $350, of which energy and raw materials account for 45 percent, labor for 35 to 45 percent, and capital service charges (including depreciation) 6 to 10 percent. To make one ton of steel in the U.S. requires 34 million B.T.U. of energy and 8.2 man-hours of labor. The book value of such a plant is about $120 per ton of annual output, but the replacement cost is about $1,500 per ton.

A detailed breakdown of these figures shows that 75% of the labor is required at the finishing end of the process, while 65% of the energy is consumed in coke-, iron-, and steelmaking. These figures have important implications for the objectives of new technologies with which one might wish to replace existing operations.

Ironmaking, steelmaking, and steel forming — current technology


Ore preparation plant
Coke Oven
Direct reduction unit
Alloying elements and addition agents
Scrap
Blast furnace
Electric furnace
Basic oxygen furnace
Open hearth furnace
Ladle
Primary rolling mill
Soaking pits
Ingots
Ingot casting
Continuous casting machine
Slabs
Billets
Blooms
Sheets and coils
Plates
Pipe and tubes
Wire and wire products
Bars
Rails
Beams

The principal problems with current steelmaking technology may be summarized as follows:

High energy requirements;
High labor requirements;
High capital cost of new plant construction;
The process is not readily amenable to environmental control;
The process may not produce the qualities which are needed or wanted for a number of uses (mechanical properties, corrosion resistance required in the future, etc.);
Specific processes are not available to suit local needs in a number of national situations (materials resources, energy availability, etc.).

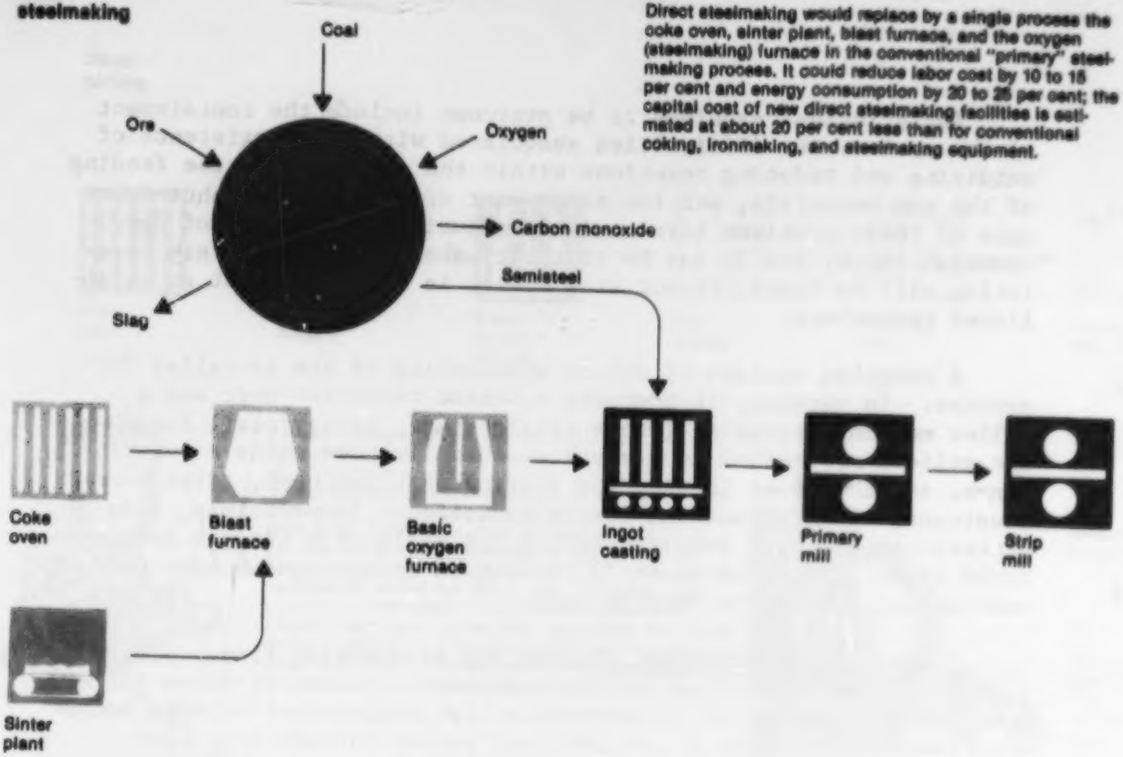
Some of these items may be more important for developed nations, while others such as the capital cost, the energy requirements, and processes for specific locations could take on special significance for developing nations. The selection of the following radically innovative steelmaking processes is at least partly addressed to these problem areas.

## Radically Innovative Technologies

Such technologies would reduce energy consumption, allow the use of cheaper raw materials, require fewer personnel in operation and maintenance, produce less environmental pollution, and meet more stringent product specifications--all at a lower capital cost. All this is not within easy reach, but we can propose some new technologies appropriate to these goals. However, they are not yet fully explored, and it must be understood that neither technical reliability nor commercial profitability is assured.

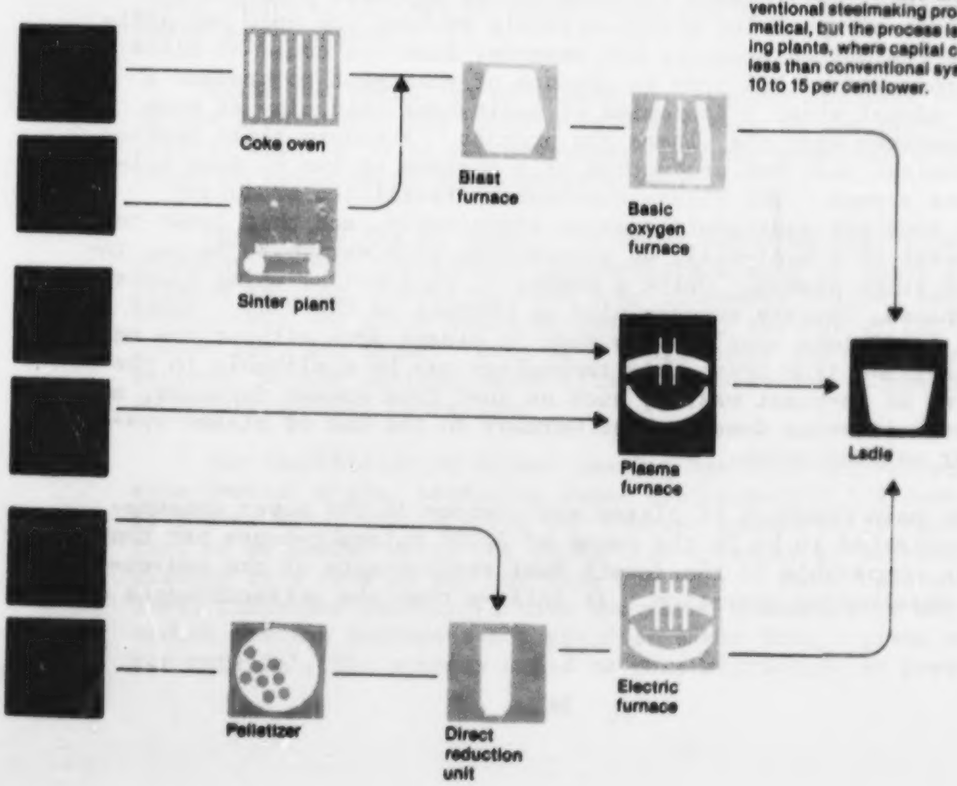
Direct steelmaking processes. One of these is direct steelmaking (see top diagram, Page 35), in which iron ore is transformed to steel with no intermediate stage. This is proposed to be done by feeding a mixture of coal and iron ore into a molten steel bath, accompanied by oxygen injection. The reduction of iron oxide to iron would take place in the molten state, with the heat of reaction supplied by the combustion of the carbon with oxygen. Such direct processes are attractive because coke is not required, because cheaper grades of coal may be used, and because ironmaking and steelmaking steps are combined. Furthermore, the carbon monoxide that is produced is given up in a continuous manner so that its subsequent utilization can be more straightforward. Direct steelmaking could save energy, capital and labor costs; no coke ovens or blast furnaces would be needed.

**Direct steelmaking**


Coal
Ore
Oxygen
Carbon monoxide
Semisteel
Slag
Coke oven
Blast furnace
Basic oxygen furnace
Ingot casting
Primary mill
Strip mill
Sinter plant

Direct steelmaking would replace by a single process the coke oven, sinter plant, blast furnace, and the oxygen (steelmaking) furnace in the conventional "primary" steelmaking process. It could reduce labor cost by 10 to 15 per cent and energy consumption by 20 to 25 per cent; the capital cost of new direct steelmaking facilities is estimated at about 20 per cent less than for conventional coking, ironmaking, and steelmaking equipment.

**Plasma steelmaking**


Coke oven
Sinter plant
Blast furnace
Basic oxygen furnace
Plasma furnace
Ladle
Pelletizer
Direct reduction unit
Electric furnace

Plasma arc steelmaking would substitute a single electrically powered furnace for the "primary" stages in the conventional steelmaking process. Energy savings are problematical, but the process is suited to smaller-scale steelmaking plants, where capital costs could be 10 to 20 per cent less than conventional systems and labor requirements 10 to 15 per cent lower.

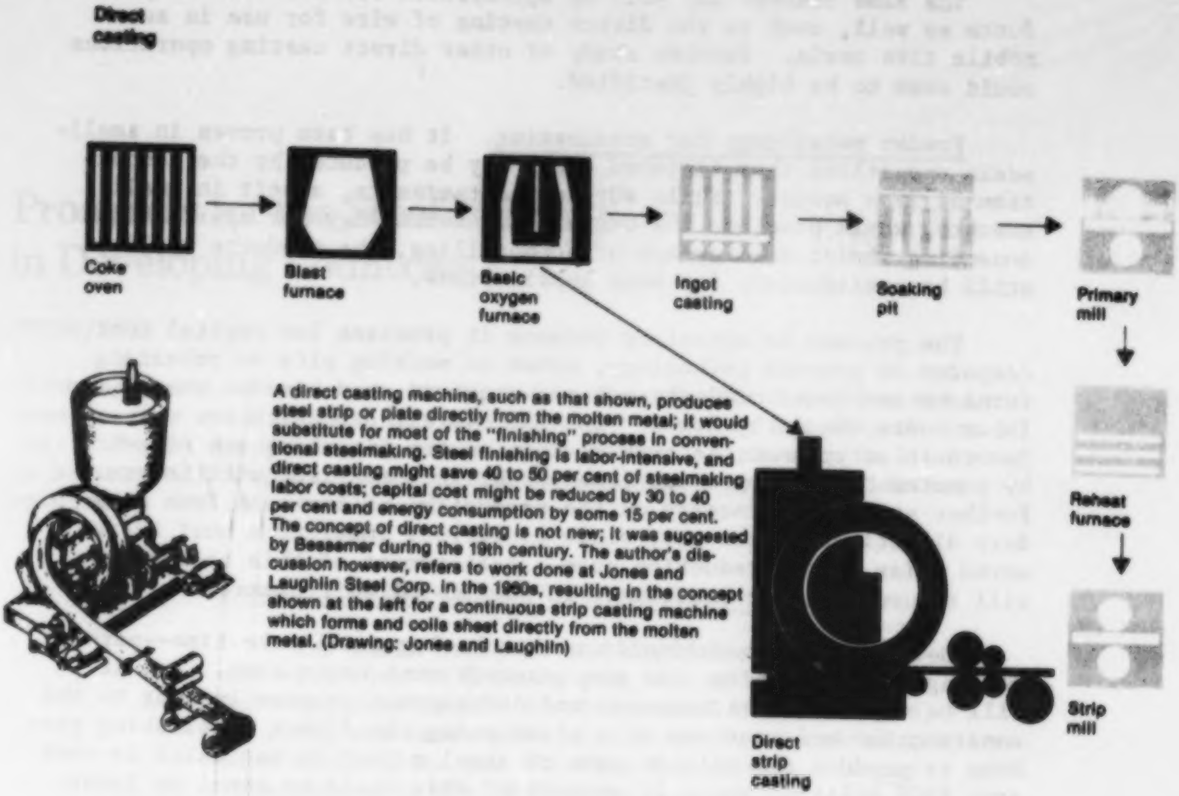
The principal problems to be overcome include the containment of the system, the difficulties associated with the coexistence of oxidizing and reducing reactions within the same vessel, the feeding of the raw materials, and the management of start-up and shut-down. Some of these problems have resisted solution in a number of developmental tests, and it may be that ultimately no satisfactory resolution will be found; direct steelmaking is definitely not an established technology.

A possible variant of direct steelmaking is the so-called "S" process. In essence, it combines a direct reduction unit and a pellet melting operation into a single stage, using fossil fuels. The pellets are melted in a vertical-shaft furnace using a reducing flame, and the gases leaving the melting unit are used, after some treatment, to carry out the direct reduction. In principle, this process--it has been demonstrated on the scale of 1 ton per hour--could offer savings of 20 to 30 percent in energy consumption and substantial savings in capital cost.

Plasma arc steelmaking. Plasma arc steelmaking (lower diagram, page 35), under investigation for a number of years, involves the creation of a stable arc of extremely high temperature between two electrodes. A mixture of ore and fuel passed through this high-temperature zone would react to produce molten iron.

This technology is appealing for several reasons. Its capital cost would be relatively low, since no coke ovens or blast furnaces would be required. Plasma arc steelmaking may make possible the manufacture of specialty steels directly without the need for additions to the molten product; for example, iron ore could be mixed with chrome and nickel ores in advance of treatment to produce a chrome-nickel steel. Economies of scale come into play at much lower tonnages with the plasma arc process. A modern blast furnace is economical only for production of a minimum of two to four million tons a year. But plasma steelmaking facilities producing 200,000 tons per year could operate efficiently, and this leads to the concept of a mini-mill, an interesting alternative to large, integrated steel plants. Quite a number of mini-mills, using electric arc furnaces, operate successfully at present in the U.S. Under certain conditions steel can be made in plasma arcs without the need for high-grade iron ores; this technology may be applicable to the recycling of in-plant wastes, such as dust from oxygen furnaces, as well; work is being done in East Germany on the use of plasma systems for melting scrap.

The main drawback of plasma arc systems is the power consumption, estimated to be in the range of 2,000 kilowatt-hours per ton which is comparable to the fossil fuel requirements of the conventional steelmaking operation. It follows that the attractiveness of



A direct casting machine, such as that shown, produces steel strip or plate directly from the molten metal; it would substitute for most of the "finishing" process in conventional steelmaking. Steel finishing is labor-intensive, and direct casting might save 40 to 50 per cent of steelmaking labor costs; capital cost might be reduced by 30 to 40 per cent and energy consumption by some 15 per cent. The concept of direct casting is not new; it was suggested by Bessemer during the 19th century. The author's discussion however, refers to work done at Jones and Laughlin Steel Corp. in the 1960s, resulting in the concept shown at the left for a continuous strip casting machine which forms and coils sheet directly from the molten metal. (Drawing: Jones and Laughlin)

plasma arc systems will depend critically on the cost of electric power compared to that of other fuels and also on the efficiency of waste gas recovery.

While the operation of plasma arc systems has been demonstrated in the laboratory, the hundred-fold scale-up to the projected commerical size of 50 to 100 megawatts may pose problems, including those of containment and electrode wear.

Direct casting of sheet. If sheet could be cast directly (diagram above), the costly intermediate stages of ingot casting, primary rolling, reheating, and some secondary rolling would be eliminated, and there could be substantial savings of capital, energy, operations, and labor. Even as a replacement for continuous casting systems, direct casting could eliminate reheating furnaces and some secondary rolling operations.

The feasibility of direct casting has been demonstrated on an experimental scale, producing sheet approximately 1/4 inch thick and 15 inches wide, and to prove the concept commercially requires only that it be scaled up to the production of sheet of satisfactory quality at a rate of say 100 tons per hour. Since capital costs for steel finishing facilities have increased dramatically and because direct casting increases the yield of sheet from a given quantity of raw material, the process could be very attractive at present.

The same concept may well be appropriate for other steel products as well, such as the direct casting of wire for use in automobile tire cords. Further study of other direct casting operations would seem to be highly justified.

Powder metallurgy for steelmaking. It has been proven in small-scale operations that finished steel may be produced by the compaction of iron powder. While surface contaminants, albeit in small amounts, would preclude the use of this technology for applications demanding strict elimination of nonmetallics, the products would still be satisfactory for many applications.

The process is appealing because it promises low capital cost compared to present technology, since no soaking pits or reheating furnaces and fewer mill strands are required, and because energy and labor costs should be lower. But the overall economics are not favorable at present, because savings in the finishing are offset by greater costs to produce iron powder in comparison with ingots. Further study is necessary on the production of low-cost iron powders directly from the ore, since nonferrous impurities must be removed prior to the reduction step. Achievement of this technology will reduce customer resistance to powder-rolled products.

Developing such radically new technology will take time--perhaps as long as two decades. So the research must begin soon. And it will be expensive. A research and development program leading to the construction and start-up of a plant using the direct steelmaking process to produce one million tons of steel a year is estimated to cost some $500 million; about 10 percent of this would be spent on laboratory-scale work. Later plants of similar capacity built after the technology has been proven should cost substantially less--optimistically $150 to $200 per ton of annual capacity for the primary end. Plasma steelmaking could probably be commercialized over a period of eight to 16 years, with research, development, and construction costs of $100 to $150 million leading to a full-scale installation. The development of direct sheet casting to full-scale operation would take about five years and a total of perhaps $50 million.

Some potentially attractive ideas have been discussed in this paper; the author is quite certain that many other new approaches could be developed, provided a better climate is created for innovation, research, development, and the implementation of research results through investment in new plants. If the case for the steel industry is perceived to be important, it would be necessary to devote substantial resources to new process development and to establish an appropriate new framework for it. This could be a very exciting and fruitful area for collaboration between industry, labor, the academic community, and government; indeed, such collaboration would be essential for the success of such a program.

[Extracted from Technology Review, Vol. 81, No. 4, February 1979, pp. 23-39. Copyright © Alumni Association of the Massachusetts Institute of Technology, Cambridge, Mass.]

# Prospects for the Steel Industry in Developing Countries

UNIDO/ICIS

[The depressed situation in steel industries of many countries and some current developments in technology are shifting the outlook for this industry in developing countries. External financing is likely to be more difficult to obtain, but technological possibilities are opening up new opportunities.]

## Recent Changes in the Iron and Steel Industry

The first study on the world iron and steel industry over 1975-2000, prepared by UNIDO's International Center for Industrial Studies (ICIS) in 1976, was undertaken within the framework of the Lima Declaration and the Plan for Action. [Note: This refers to the 1975 UNIDO Conference, which called for a 25% share of the world's industries to be located in developing countries by the year 2000.] Since 1976, however, changes have taken place in the steel industry which affect trading, the prospects for location, and the problems of financing. These have led the ICIS to prepare a new examination of the situation. During the second half of 1977 authoritative voices were heard affirming that the widespread recession in iron and steel production arose not from the familiar cyclic economic situation (which would have reversed itself by then), but rather from a structural phenomenon involving major transformations. This cast doubt on the reliability of the instruments forged during a long period of continuous growth for the measuring and forecasting developments in the industry.

New analyses suggest that we are entering a period of increasing uncertainty--uncertainty in fore-

Study prepared by the International Center for Industrial Studies (ICIS) of the United Nations Industrial Development Organization (UNIDO), with headquarters in Vienna, Austria.

casts, doubt concerning the methods used, and fluidity in the strategies of the nations concerned. Changes in the structure of the iron and steel industry affect various groups of countries in different ways. The industry is one where national governments are heavily involved, either directly or indirectly, not only in the centrally-planned-economy countries but also in the developing and market-economy countries.

The world's output of steel has been depressed since 1974. The annual production figures in millions of metric tons were: 1974-708; 1975-646; 1976-676; 1977-674. [In 1978 the world total returned to 712, with world capacity at 810-820; Western Europe and Japan were operating well below their capacity.] After more than 40 months the traditional explanation of lowered output as reflecting the "steel cycle" loses validity; structural transformations seem to be taking place. In this context it is necessary to examine the medium and long-term projections for demand and production of steel, and note how they have recently been shifted downward.

## Medium and Long-Term Projections

The study of the world iron and steel industry carried out in 1976 by the ICIS contains forecasts for the world demand and production of steel for 1985 and for the year 2000 (Table 1). These forecasts were based on a continuation of earlier trends, with some slowing down of growth in the developed countries balanced by strong sustained growth in the developing countries.

Table 1: ICIS Forecasts in 1976

| | Millions of metric tons | | Annual growth rates (%) | |
|---|---|---|---|---|
| | 1985 | 2000 | 1975-85 | 1985-2000 |
| Consumption | 1,069 | 1,665-1,925 | | |
| Developing Countries | 170 | 395-655 | 7.8 | 5.8-9.4 |
| Developed Countries | 899 | 1270 | 3.0 | 2.0 |
| Production | 1,069 | 1,665-1,925 | | |
| Developing Countries | 125 | 378-487 | 12.0 | 7.7-9.4 |
| Developed Countries | 944 | 1,287-1,438 | 2.8 | 1.5-2.6 |

Since the beginning of the fifties the iron and steel world had become accustomed to a steady average rate of growth in the consumption and production of steel: nearly 5% per year between 1955 and 1974, 6.2% from 1960 to 1965, 5.3% from 1966 to 1970. The steel economic cycles, covering periods of about 40 months, showed variations oscillating around this sustained trend. The Conference of the

International Iron and Steel Institute (IISI) held in October 1974 showed the confidence of those in the iron and steel industry in a continuation of this growth: it forecast that the year 1975 would show an increase in annual production of 4.2%. The 9% fall in the world production of steel in 1975 was thus completely unexpected.

Nevertheless, expectations of steady and sustained growth were so profoundly ingrained that the estimates and forecasts made in 1976 by a variety of national experts for the period 1980-1985 ranged from only moderate pessimism to marked optimism. This prolonged optimism was partly based on the announcement of an extensive "redeployment" of the iron and steel industry towards areas better provided with energy, minerals and capital, and away from those northern European or Japanese sites which were threatened by high levels of pollution. The survey carried out in 1976 by the EEC on investments in the coal and steel industries indicated that "the unfavorable economic situation in 1975 has not prevented companies, with a few exceptions, from carrying out the investment programs which were in hand or already decided on."

The prolongation of the recession in the iron and steel industry in many countries into 1977 caused a modification of these views, as was shown at the annual IISI Conference held at Rome in October 1977. The Secretary General's report noted that the various indicators which were available gave little comfort and that, while the recession had principally affected the market-economy developed countries, the developing countries--particularly Latin America--were not unaffected. He concluded that: "The present period of lower demand for steel has brought in its wake increased competition on the international level, lower prices, and what is generally described as the steel crisis." Whereas the Eighth Annual Conference in 1974 had estimated the net new capacities to be installed between 1974 and 1985 in the market-economy and developing countries as 240 million tons of crude steel, these forecasts were reduced "after a very careful examination of all the projects" to 142 million tons, divided up as shown in Table 2. These estimates were not exaggeratedly pessimistic; the information available during 1978 has seemed to indicate they were realistic.

The "crisis" has today become the central subject of commentaries and analyses relating to the development of the world iron and steel industry. Many of these have a tendency to enlarge on the dramatic character of the phenomenon. The iron and steel industry in the centrally-planned-economy countries, however, continues to expand, and this applies also to the developing countries. Thus, a condition of widespread and relatively steady growth has given place to national or continental changes which are diverse, and sometimes abrupt. This development has provoked considerable unease, the more so since the causes of these abrupt changes are still obscure, and the statistical or other tools available at present do not make it possible to answer the new questions which are posed.

### Table 2

### Estimates by the International Iron and Steel Institute of the Additional Iron and Steel Capacities to be Installed Between 1974 and 1985

(million tons)

| | 1974 Estimates | 1977 Estimates | % Reduction | Capacity Installed '74-'77 | Capacity to be Installed '78-'85 |
|---|---|---|---|---|---|
| ECC | 41.3 | 23.6 | 43 | 14.5 | 9.1 |
| Other Western European Countries | 26.7 | 14.1 | 47 | 9.2 | 4.9 |
| North America | 28.5 | 13.0 | 54 | 3.9 | 9.1 |
| Latin America | 37.2 | 30.7 | 18 | 13.3 | 17.4 |
| Africa | 12.3 | 5.4 | 56 | 3.8 | 1.6 |
| Middle East | 23.8 | 9.5 | 60 | 2.8 | 6.7 |
| Far East* | 67.9 | 43.9 | 35 | 17.0 | 26.9 |
| Oceania | 2.3 | 1.8 | 22 | - | 1.8 |
| TOTAL | 240.0 | 142.0 | 41 | 64.5 | 77.5 |

*China and North Korea are not included.

## Forecasting Methodology

The difficulties in forecasting are not specific to the iron and steel industry; other sectors are in the same position. The difficulties are accentuated when sectors are particularly sensitive to macro-economic variables; forecasting their long-term development seems highly uncertain today. Sectoral expertise is now being disarmed by external uncertainties; technological forecasting is therefore affected. In the case of the iron and steel industry, the IISI has started revising its projection activities from the ground up by analyzing all the available data on developments over the last four years to identify, by successive tests, those correlations (and, as a consequence, the methodological approach routes) which are significant.

For example, the critical analysis carried out by the IISI on its own research methods has drawn attention to the low degree of correlation between the per capita national product and the level of steel consumption (steel intensity factor) in the developing countries. The countries studied were the Republic of Korea, Mexico, Brazil, Iran and the Philippines. The study of these examples suggests, by contrast, the importance of that part of the national product which is allocated to fixed capital formation as related to the development of steel consumption; this high correlation was also confirmed in the case of Colombia and Tunisia. This is leading to more intense study of steel consumption in particular sectors. Some of the problems involved are: a) predicting the future substitutability of steel and other metals, materials or plastics in different uses; b) the effects of future energy costs on the life cycles of durable goods (e.g. automobiles, electric appliances).

Another method used by several developing countries to project the demand for steel is to assume that the national consumption of steel at this or that date can be approximately evaluated from the consumption of steel in another reference country 10 or 15 years previously. The value and efficiency of such a method of temporal relationships depends upon how well-based are the analogies between economies situated at different stages of development. This leads into the problems which are linked to the steel intensity curve, that is to say the hypothesis of a national pattern in the quantity of steel consumed per capita that increases and passes through certain predictable stages before reaching a culminating point, approximately defined in the work of the IISI by the steel consumption of the United States (approximately 500-550 kg per capita).

The determination and employment of this culminating point poses several questions: a) If per capita steel consumption has already arrived at or is close to its "maximum" level, is no significant increase probable up to the year 2000? Under such conditions is it probable that the consumption of steel in Europe and Japan will fall short of the American consumption? What will be the consumption of the developing countries: will it pass through the various stages of a curve at the same rate, or with a time delay, or will it involve a different rate and structure? b) Will the curve of growth in per capita steel consumption in the USSR flatten out, or will it continue to rise up to the year 2000, well beyond 600 kg per capita per year, under the influence of the high priority given to heavy industry and infrastructures? c) What is the real significance of the "summit" of the steel intensity curve reached today in the United States? Does a descending phase automatically follow this culminating point? No country yet has experience of an economy which has arrived at this stage. These questions significantly enlarge the field of investigation to find methods suitable for grasping the development of the demand for steel and of the world iron and steel industry.

## Outlook for the Developing Countries

Despite uncertainties, some convergence of opinion can be seen on the 1985 prospects. The world demand for steel in 1985 will probably be less than 1,000 million tons but at least 960 million. [Other recent estimates center around 900-950.] Steel production in the developing countries in 1985 is likely to be less than 150 million tons, since the projects which are capable of entering into production by that date represent a new capacity of less than 55 million tons--excluding China. [Note: 150 million was the figure used earlier by UNIDO; current forecasts center in the 100-125 million range.] Among developing countries, China is in a class by itself with its production of 30 million tons in 1977, the size of its coal and iron ore resources, and its capability for making its own steel manufacturing equipment. In 1978 its plan was to reach 60 million tons capacity by 1985. [In 1979 this was revised down to 45 million tons.]

A large number of the iron and steel plants installed in the developing countries are limited to the production of "long" products and, in particular, to the production of concrete reinforcing rods, along with wire rods and small merchant products. Multi-product installations which produce long products (concrete reinforcing rods, merchant goods up to large beams and rails) as well as "flat" products (hot and cold-rolled sheets, subsequently tinned or galvanized) exist in only a limited number of developing countries. The number of producers of alloy steels amongst the developing countries is even smaller.

The weakness in the production of flat products and also of alloy steels indicates an iron and steel industry limited to paths which can be described as "secondary." The production of machinery and durable consumer goods necessitates both: flat products--thick plate for heavy equipment, thin sheet for durable consumer goods (automobiles, domestic electrical appliances); and alloy steels, whether special steel sheets for the chemical industry, or various parts for the manufacture of motors, turbines, alternators, etc. The developing countries at the present time remain largely outside these circuits, restricted to the production of long products used by the building and public works industries or the production of semi-products for local finishing. This raises the question of the criteria for access to production potential, and the constraints on the development of new activities in this industry.

The national availability or non-availability of iron ore and coal resources are important factors, but not decisive constraints. Recently some countries lacking these resources have shown the most rapid rates of expansion: the industries in Japan and the Republic of Korea, and the non-integrated or semi-integrated steel industry in the Brescia region of Italy are the most striking but not the only cases.

The criteria of dimensions concern the size of the population and the market. Aside from Qatar and Abu Dhabi, which are in an exceptional situation as oil producers, no country with less than a million inhabitants has constructed an iron and steel project. No developing country with less than 10 million inhabitants (except Chile) possess or has constructed a capacity for the production of flat products. All this must be taken into account. However, it is less certain that a finding at any given moment from the state of techniques and markets can be erected into a rigid principle. Does, for example, a capacity of 1 million tons constitute a minimum threshold for constructiing a production unit for long products in a country of 8 million inhabitants with a per capita consumption of 130 kg? This is not so certain when techniques are evolving, and where factors of production are capable of combining differently in the future (see discussion below).

The development of iron and steel industries in the developing countries has resulted in some additional exports to world markets, but their volume will probably be limited for some years to come. It is true that the iron and steel industry in the Republic of Korea has systematically and efficiently launched itself into major exporting activities; but this is not true in the same degree for the other and most advanced iron and steel industries in the developing countries. India, Brazil, Venezuela, Mexico and Argentina have, to be sure, announced that their iron and steel industries would become exporters, and in some cases major exporters, in the long, medium or even short term. In fact India and Brazil have begun to export from 500,000 to 1 million tons per year; but the quantities exported are not likely to increase rapidly in the coming years. Development prospects of the iron and steel industries have been or are being revised. It seems that everywhere, even if more moderate exporting objectives remain, a greater priority will always be given to satisfying the rapidly increasing demands for domestic consumption.

A few developing countries have acquired the ability to produce their own equipment for iron and steel mills. Brazilian industry is capable of supplying 70 to 80% of the equipment necessary for building a large integrated iron and steel unit; China has already supplied the equipment necessary for building an iron and steel unit in Albania; India is also very advanced in this field; Mexico and Argentina are capable of making many parts of the iron and steel equipment.

Recently a large number of export-oriented iron and steel projects in developing countries that were linked to the process of "redeployment" or relocation to new areas (mentioned earlier), projects devised and financed by the major Japanese and European iron and steel companies, have been abandoned, and others have been scaled down. Mitchell Hutchins noted in May 1977 that, as compared to early 1976 when 49 "green field" site plants (i.e. plants in new non-urban areas including many in developing countries) were planned which would add some 33 million tons to world steel capacity by 1989, a year later this estimate was sharply reduced to 12 million tons. Of 44 plants under consideration, 31 had been "abandoned," 10 may be under construction by 1980, and 3 may be "on order." In 1978 the situation seemed to be worse. [Note: Such estimates, of course, can vary over time.] New European plants have also been affected; and world steel capacity for some years ahead has thus been set back. However, this trend provides an opportunity to accentuate the priority given to strategies favoring national or regional integration, which may have positive aspects. The revision of present strategies in many developing countries seems to be moving in this direction, toward the construction of more locally oriented facilities, although not to the complete exclusion of active participation in world trading.

## Effects of Some Technological Developments

Iron ore. The developing countries (including China) own 30.4% of the world reserves of iron ore, but they have been supplying about half of the world exports, a share which will continue through the 1980s. The present growth of the so-called "waterside" units of very large size has, in fact, accentuated the pressure on exports of high quality African, Latin American and Asiatic ore--Also Australian and Canadian ores. In general the most interesting deposits, because of their content, purity, size or closeness to the coast, have already been worked. In coming years it will be necessary to satisfy both the demand for exports together with new national requirements from ores more costly to extract and/or transport. World reserves of iron ore are abundant, so that theoretically no long-term supply problems are present. However, the opening of new mines has become a very expensive operation requiring the mobilization of very considerable amounts of capital. At the present time it seems that many important mining projects, although recognized as economically valid, are being held up for lack of external financing.

Recent developments in the iron and steel industry have favored the production of high quality ores to be used in large blast furnaces. The development of direct reduction will also operate for some time in favor of very pure and high quality ores. Such developments tend to make ores of lower quality and lower purity of less value. However, several experiments in the construction of iron and steel industries--particularly in China--demonstrate the possibility of using in an economic manner ores which are neither of high quality nor very pure.

Reducing agents. Coke is the traditional reducing agent used in the iron and steel industry. This is obtained from coking coal, 94.8% of the deposits of which are in the developed countries. With respect to non-coking or low-grade coals, the developing zone has 14.6% of the world reserves, and China and India have practically all these reserves. Wood charcoal was for several centuries the only reducing agent used in the production of cast iron and iron; its use is now exceptional, Brazil being one of the rare countries to operate modern blast furnaces on charcoal. The use of charcoal cannot be greatly increased since about 30,000 hectares of forest are necessary to supply a very small blast furnace of 100,000 tons per year.

The developing countries, on the other hand, are much better provided with natural gas (45.8% of the world resources), petroleum (79.0%), and hydroelectric power (62.7% of the world potential). The distribution of these resources favors the Middle East and Africa (North Africa for gas and petroleum, Central, East and West Africa for hydroelectric power), regions which are poorly endowed with coal (coking or otherwise) and forests. These realities demonstrate the interest for many regions which lack coal resources, and have therefore remained on the margin of the iron and steel industry, in the development of viable alternatives to coke.

Direct reduction processes. The direct reduction or prereduction processes are so named because they make it possible to achieve economies in costly installations by passing directly from iron ore to a product called sponge iron which is capable of being charged into an electric furnace to be converted into steel. These processes operate either with a solid reducing agent (low grade coal), or a reducer in gas form which then uses a stack furnace, a fixed bed, a fluidized bed, etc. There are a number of different processes available today, only a few of which have proved their profitability.

Research work on the direct reduction of iron ore resulted in the construction in Mexico in 1957 of the first direct reduction unit of 200 tons/day. The process, to which the company gave its name HYL, uses natural gas and produces, from a high grade ore, iron pellets which are then converted into steel in an electric furnace. This was a major innovation, making it possible to open up, alongside the classical blast furnace route, a new iron and steel route--the more so when direct reduction could be coupled with electric steelworks, and where the availability of natural gas could provide both the reducing agent and a cheap source of electrical energy.

In practice this innovation remained a strictly Mexican affair for a long while, and it was the object of very considerable caution in world iron and steel circles for a decade. By January 1977, however, total capacities of 8.8 million tons were in production in a number of countries, and capacities of 22.2 million tons "were the object of a contract with prospects of completion before the end of 1980." Up to 1977 the industrialized countries owned about 75% of the direct reduction installations, but 60% of those which were to enter into service from 1977 to 1980 are in developing countries. This proportion will be maintained for projects retained or studied up to 1985 and beyond. Mexico, Venezuela, Brazil, Iran, Iraq and Indonesia are the countries which have made a deliberate (though not exclusive) choice of direct reduction.

In the industrialized countries direct reduction units have recently been closed down, construction of new units has been held up, and various projects have been frozen because the price of scrap iron, the substitute for sponge iron, is still falling. As Metal Bulletin (September 27, 1977) put it, "with prices of scrap iron so low, iron and steel technicians have no encouragement to invest even the most modest sums in the production of sponge iron, even if it can be clearly seen that when the steel market improves the supply of scrap iron could shrink very rapidly." However, a Spanish iron and steel technician has states: "It is clear that there will be a shortage of scrap iron. It is clear that direct reduction is the solution...therefore we must start on this."

The "breakthrough" at the end of the sixties and early seventies gave priority to direct reduction processes based on gas, either natural gas or reforming gas, and most of the units constructed or planned so far employ the two principal processes using gas (MIDREX and HYL). The immense reserves of natural gas in the OPEC countries have opened up very large prospects to these processes. However, attention should be drawn to the advanced tests carried out in the United States on the direct reduction of iron ore using low grade (lignite) coal. Much research work is currently being carried out to promote processes with a solid reducing agent, or to make possible the use of several types of solid or gaseous reducing agents. This opens up a possibility for regions which have large resources of low grade (lignite) coal, that is to say the US, USSR, and Germany but also Brazil, the Balkans (Bulgaria, Yugoslavia, Greece), India, Australia and probably China.

The major potentialities which the direct reduction process opens up are only now beginning to be appreciated. Sponge iron is a high-quality product which can be used not only for the production of ordinary steels but also for fine and alloy steels. It has been proved in Mexico, as in the Argentine, that sponge iron is an excellent material for the production of special steels. In addition, very optimistic evaluations have been made concerning the cost advantages presented by direct reduction processes as compared with the classical blast-furnace processes. In the case of the Venezuelan SIDOR installations the investment, including continuous casting but excluding the rolling mills, was 40% lower than the investment which the classical route would have necessitated; and this resulted, in operating costs, in a 20% gain in the cost of producing slabs. These evaluations, however, must be treated with a certain amount of reserve while awaiting their verification when the installations are completed and put into service.

It would seem that the direct reduction processes are characterized by flexibility as compared to blast furnaces. Concerning the ores which can be used: up to now there has been an insistence on the high iron content required, but recent developments are tending to enlarge the range of ores which can be used in the direction, for example, of sulphur-containing ores. This aspect is the subject of active experimental work. From the point of view of the reducing agents, certain of the processes previously developed for the use of low grade coals can accomodate themselves to fuel oil, natural gas or coking gas.

From the point of view of size: the normal size of direct reduction installations is in the region of 300,000 - 600,000 tons per year, depending on the particular process selected. Several of the processes make it possible to envisage not only much smaller sizes, down to 20,000 tons per year in the case of the

Italo-Swiss Kinglor-Metor process, but also much larger sizes, since the possibility is now being studied of producing units of 1,000,000 tons per year. At all events, since the number of direct reduction units can be multiplied in one site, there is nothing to prevent the construction of integrated iron and steel units of several millions of tons annual capacity using this process. It is this which is now being done in Venezuela with the extension of the SIDOR unit at Matanzas. At the same time the complementarity of direct reduction units with large classical steelmaking units has been shown to be extremely profitable, since small direct reduction units are able to use and valorize steelmaking dust in producing sponge iron. From the very smallest size to the largest size the direct reduction processes enlarge the range of possibilities for access to the iron and steel industry. This is of great interest for all concerned, in particular in the developing countries.

If direct reduction is to become effectively and universally accessible, however, it is necessary that these processes can operate within a wide variety of contexts. This assumes that the following problems are solved: 1) So far, only those processes using gas have demonstrated that they can be profitable, although other possibilities are known--as mentioned earlier. Thus, a major problem is the development of cost-effective processes using using other energy sources. 2) Size and modules: The advance of solutions is rapid, both in respect of installations of very small size (20,000 t/year) and those of very large size with unit modules of 1,000,000 t/year. 3) The ores which must be used: Development of the use of local ores, and not only high purity ores, constitutes one of the requirements for a more rapid utilization of direct reduction. This problem is not given the highest priority amongst those who have the research capabilities. All the leading processes are controlled and offered by companies of the market-economy developed countries. Any discussion on technical cooperation in the iron and steel sector should consider the progress of direct reduction processes in the developing countries, including R&D to make it possible to speed up the adaptation of the processes to a variety of contexts.

## Size and Scale Economies

Many of the developing countries are small: more than 50 of them have less than 1 million inhabitants. Industrialization of these countries must confront the general trends towards economies of scale. Today scale economies affect most of the sectors of the economy--large freight aircraft and bulk ore carriers, and supermarkets; but scale economies are most strongly experienced in industry. Physical phenomena linked to increases in the size of equipment and instruments improve performance, so that an industrial unit of large size costs less per ton of output than a smaller installation. During recent decades systematic research into scale economies has been accelerated and has become accepted as a world standard: the standard of "scaling up." A large proportion of the new equipment introduced has consisted in scaling-up innovations; this has been especially true in Japan and in the USSR.

Up to the middle of the nineteenth century the iron and steel industry was characterized by units of small size which used local resources of iron ore and wood charcoal, and which supplied local markets. The replacement of charcoal by coking coal did not initially bring much increase in the size of blast furnaces. The first moves towards larger dimensions took place from 1860 onwards when the increasing requirements for rails for railway construction in Europe encouraged the development of steel produced in large quantities by the Bessemer process, rapidly followed by the Siemens-Martin process and by the Thomas process. Until the twentieth century, 100,000 to 200,000 tons of annual capacity was an average size for integrated units. The second move forward was started in the United States under the pressure of a massive consumption of sheet intended for the automobile industry, for domestic electrical appliances, for packagings and also for transport and oil refining. The first hot rolling mill for wide strips dates from 1926; its capacity was 600,000 tons. Fifty years later, integrated units for the production of flat units have capacities ranging from 3 million to 10 million tons; the size of steelworks and blast furnaces has shifted upwards until the Japanese built giant blast furnaces with a capacity of 5 million tons of pig iron a year.

Recent data on capital costs per ton of capacity indicate that the scale economies obtained in building the blast furnace, and the classical route (blast furnace + oxygen steelmaking), are very considerable. By contrast, the scale economies are considerably less substantial in the direct reduction/electric furnace route. To obtain capacities of more than 400,000 tons per year, it has until recently been necessary to juxtapose several direct reduction modules and several electric furnaces. However, scale economies tend to be found in all the routes of iron and steel production when larger enterprises can obtain systematic gains in the cost of capital and, as a consequence, gains in operating costs. This "law" of increasing returns to scale makes it difficult for developing countries of small or medium size to establish an iron and steel industry.

But now the universal value of the concept of scale economies is beginning to be questioned. Experience which is accumulating in developing countries indicates that this law operates less uniformly than had been assumed. Furthermore, the continuing steel crisis exposes vulnerabilities in what had been considered very solidly based enterprises in the industrialized countries. Scale economies bore their fruit during the long period of growth, at the time when industrial installations operated at high utilization levels of over 90% of their capacity. The crisis has made these levels fall over extended periods to below 80%, sometimes to below 60% in certain European industries. The damage caused by operating this much below capacity is the more noticeable when very large units are involved. "The crisis has shown, amongst other matters, ...the greater adaptability of the so-called mini-mills..." (Metal Bulletin, May 9, 1978). Other disadvantages linked to large size are not related to the crisis, in particular the longer construction period before entering into operation, and the longer subsequent time for raising production up to the normal running rate in very large iron and steel units. This extension of the time necessary arises from the difficulty of mastering a complex assembly of very large size, where the continuity of the process implies precise articulation between the various sections, together with efficient adjustment to the environment. As the scale of sizes rises, so the "teething problems" are extended over two, three or even four years.

These phenomena are amplified in developing countries. The time necessary for building an iron and steel unit in a developing country is now much longer than the normally accepted standard in the developed countries. Recent examples indicate that an integrated iron and steel unit of 2.5 million tons was constructed in 36 months in an EEC country, and an iron and steel unit of 1.0 million tons was built in the same time in Eastern Asia; whereas it took 80 months to build a unit for 0.5 million tons in Africa and the Middle East. Such delays are very expensive: it can in fact be calculated that each month of delay increases the initially forecast investment by 1.2 to 1.4 percent. Entry into production also takes much longer in the developing countries. Aside from supply bottlenecks and other coordination problems, the mobilization and adjustment of a large work force is more difficult in a non-industrial environment. The developing countries have experienced so many obstacles in the training of personnel--irrespective of where the training took place--that it has encouraged them to rethink the problem of training as a function of the size of the production unit, and of other parameters not taken sufficiently into consideration, in particular the links between the technological processes and the form of individual and team work.

The available information on the developments which are taking place in both types of countries tends to call in question the universality of the law of scale economies. Recently, it has been noted that an iron and steel production unit consists not only of surface areas and volumes but also of a group of workers required to master technical processes which are increasingly continuous on the basis of complex machine systems. Such a mastery can only be progressive; it implies stages--social laws and not simply physical constants. This context needs to be better perceived, better evaluated and analyzed to arrive at the definition of thresholds from which scale economies can effectively operate. The move towards "scaling-up", considered for a long while as irreversible, developed in the most advanced industrialized economies, USA, USSR, Japan, Germany, etc. which are or have been economies of world scale. Today the crisis phenomenon, together with the desire for industrialization of numerous smaller developing countries present new problems: not only those of scaling-up but also those of scaling-down, of new approaches to what might be termed "miniaturization."

In order to advance along this route consideration must be given to numerous concrete experiences which fall outside the normal. The "mini-mills", or small-size iron and steel units, have multiplied over the last fifteen years in Italy, where the companies in the Brescia regions have been given much publicity; but this also occurred in the United States, in Spain, in Great Britain and in Japan. These are iron and steel units with unit capacities of 50,000 to 150,000 tons per year: non-integrated simple rolling units, semi-integrated units using UHP electric furnaces operating from scrap iron, and integrated units using the direct reduction/electric furnace route. These units specialize in the production of concrete reinforcing rods and also merchant products.

The problem of small size, which seems to be solved in the case of concrete reinforcing rod and small merchant goods, continues to be posed in the field of heavy sections and rails, but particularly in the field of flat products, in the production of slabs, hot-rolled sheet and heavy plates. The size of the mini-mills would therefore be inadequate to integrate modern rolling mills producing flat products. However, it is important not to ignore the possibilities which do exist regarding certain products in this category. Some authorities feel that "by accepting a product of slightly lower quality, it is possible to produce flat products in small size units using mills of the Steckel or Senzimir type. At the present time this is exceptional, but technical developments are possible in this field." (A. Van der Rijst and H.H.J.M. Derkx) For example, a new unit recently installed in Great Britain with a capacity of 250,000 tons is competitive in its hot rolling mill, which produces flat products, with the production of a major integrated iron and steel unit nearby. Initially the quality of these products may not be as good, but the highest quality is not required for all uses of flat products. It would be advantageous to identify, in the developing countries interested, what proportion of the possible uses are consistent with the quality obtained from medium-sized flat product rolling mills. This proportion would probably not be negligible.

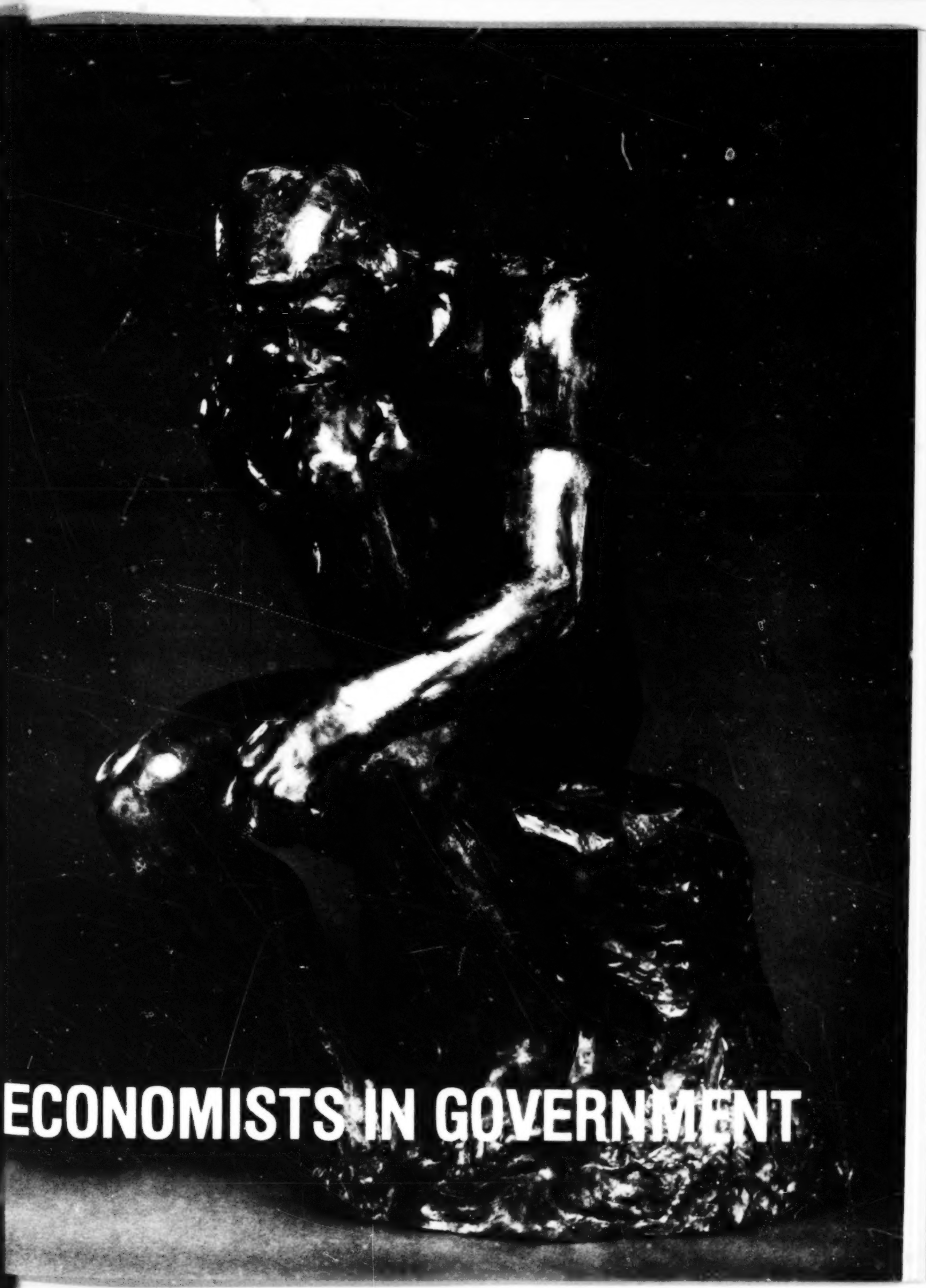
If production of "the bottom of the range" of products were to move from the larger installations to the profit of the smaller and medium and hence less expensive installations, this runs the risk of depriving the larger installations of the mass production, of the income essential for their profitability--that is to say for the operation of scale economies. The stakes are therefore high. These potential "portents of the future" are important for developing countries which wish to master the various ranges of iron and steel production. This is why the analysis of concrete experiences in medium-sized iron and steel units should be carefully undertaken: in Yugoslavia, Bulgaria, Egypt, Chile, Algeria and New Zealand, and anwhere medium-sized units integrate the production of flat products or medium and heavy sections. It is of value to compare these realities, diverse as possible, with what has been put forward as the imperative of scale economies.

[Another important factor not described here is the sharp increase in mill and mine construction costs, which aggravates the problems of obtaining financing for projects in developing countries. This too may contribute to a move toward a scaling-down in size of steel installations in these countries.]

In conclusion, it appears that the future directions of development in the iron and steel industry are much less clear and predictable than they appeared previously. But this is not necessarily bad news for the developing countries. The availability of finance is probably lower than before, to be sure, but the technical evolution in the industry seems to be opening new opportunities. Perhaps all that can be foreseen is diversity: different countries are likely to move in a greater variety of directions than was possible heretofore, and with a more strongly local orientation.

[Adapted from The World Iron and Steel Industry (second study), published by the United Nations Industrial Development Organization, November 1978. United Nations document No.: UNIDO/ICIS.89.]

Note: Inserts in brackets providing updating were largely based on William T. Hogan's article in Center Lines, Vol. XIV, May 1979.



# ECONOMISTS IN GOVERNMENT

SCULPTURE OF "THE THINKER" BY AUGUSTE RODIN SYMBOLIZES THE PRESENCE OF INTELLECTUALS IN GOVERNMENT. (PHOTO: COURTESY OF THE NATIONAL GALLERY OF ART, WASHINGTON, D.C.)

# Economists in Government: The Case of Malawi

B. D. Giles

[The way in which economists are successfully integrated into the machinery of government in Malawi is described and briefly compared with Zambia. The author has served as an economist in several African governments.]

Most of the functions of an economist working for the government of a small African country, and perhaps other countries as well, can be classified under three very broad headings: analysis, information and communication.

(1) Analysis - selecting, and if need be, adapting the analytical tools relevant to each job as it comes along. Nobody needs theory more than the practical man; the choice of which model or models to use as the basis for advice is one of the more important decisions that has to be made.

(2) Information - The economist is the recipient of information, some qualitative--both verbal and written--and some quantitative, from accounts of government and business, consultants' reports and above all official statistics. He may be able to make a marked contribution to the quality of this last class of information by trying to ensure that the data collected are significant for his purposes. For example, he can check the questionnaire used in a census of production to see that the definitions are such that the material can be used for compiling national accounts. In a census of population he can press for questions that will provide frequency distributions by age, education and occupation, even if it means ex-

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cluding some questions of interest to religious and political bodies. In doing this he must take a long-term view; often he must try to anticipate what he or his successors will want to know ten or more years later, and persuade the statistical office to collect and process it.

(3) Communication - feeding the results of economic analysis into the decision-making machinery of government in such a way that the economist's view is taken into account. Although rarely discussed at length in the economic literature on development, this feature of the job is at least as important as the other two. The finest analysis based on the very best information will be sterile if it is not even considered by those responsible for taking decisions. This is the problem that will be discussed in detail in this paper, on the basis of personal experience in Malawi and to a lesser extent in Zambia, Lesotho and Swaziland.

Economic advisers and planners, however competent, suffer from two main handicaps, namely an almost total lack of understanding of their function by laymen, and the risk of complete uselessness if cooperation from other professionals is not forthcoming. Whereas it is reasonable to assume that an educated layman has some idea of what to expect from civil engineers, veterinary surgeons, agronomists and doctors, it is almost, if not quite impossible to explain to a non-professional what an economist can and cannot do. When I arrived in Lesotho in 1965 as the first professional economist in that country's government, I was variously regarded as some kind of accountant, an expert in setting up factories in mountains, or the holder of a key to the vaults of some of the world's larger financial institutions. It was not until I became involved with customs negotiations with South Africa, and was able to demonstrate in one field that economic analysis can throw light on important problems, that there was any understanding of why an economist should be employed at all (apart, of course, from the need tc present a facade of respectability to the World Bank and other aid agencies). In Swaziland in 1969 I felt constrained to leave a paper behind explaining what the economic planning office could do; and in Zambia in 1975 I was left with no doubt that the government neither knew nor cared what the twenty-five economists in the Ministry of Development Planning got up to so long as they produced a volume for public consumption to be called the Third National Development Plan. My experience may well be fairly typical. Ministers and civil servants normally determine the allocation of resources without taking much account of economic advice, and the economist is confined to doing a cosmetic job on programs approved elsewhere in government and acting as junior advocate before financial agencies when the government seeks external funds. It is reasonable to suppose that economists are often bypassed because nobody knows what they can be asked to do.

And, of course, economists can do nothing of immediate use on their own. They can speculate about consumption functions and the like in the abstract, but that is usually as far as they can go. They cannot, for example, design a road or supervise its construction; but, given some cost estimates, data on permissible axle loadings, traffic censuses and vehicle running costs, they can make an investment appraisal which may influence decisions on which roads to build. In general the contribution to development that economists can make is much more dependent upon cooperation with laymen than is the case with most other professions. After all, most of the world's development to date has occurred with little assistance from economic analysis, and Keynesian 'animal spirits' still determine more investment decisions than does discounted cash flow.

These two factors--ignorance of the subject and the helplessness of the economist in isolation--are probably sufficient to explain why economists are usually ignored. That they sometimes say things that the people in power do not want to hear only makes things worse.

What in fact can an economist do for a government? Perhaps the most comprehensive answer is that he may be able to improve the quality of the decisions taken in some areas. Economic planning offices do not determine economic policy, and their powers are often grossly over-rated by implication in the theoretical literature on planning and by visitors--except for those more experienced staff members of aid agencies who know that a Secretary for Finance, or Agriculture usually carries far more weight than a Director of Economic Planning. At most, the economist in a planning office or elsewhere can set out the economic implications of any proposals, ask questions that may be awkward, and draw attention to inconsistencies and alternatives. Only if the economists are allowed to make these contributions can they demonstrate their worth.

It might be thought self-evident that economists employed by governments would automatically be accorded a hearing. Not so. They are all too easily frozen out by executive ministries or simply ignored. Donor countries and international agencies, in their technical assistance programs, press economists on poor countries and offer generous post-graduate training to local economists, but the recipient government rarely feels greatly in need of them. This is shown by the alacrity with which the ablest economists in government service are transferred to administrative and diplomatic posts--it does not happen to anything like the same extent with engineers or doctors or lawyers.

These problems cannot be resolved overnight. If they are to be overcome they require that economists be integrated into the day-today machinery of government so that there is a regular 'drip-drip-drip' of economic commentary into the counsels of the nation at all levels. More economic rationality is likely to find its way into the making and execution of policy by treating economists on a par with other professional advisers than by setting them to make comprehensive plans which can be comprehensively ignored and which, given the shaky nature of their factual and theoretical foundations, deserve to be ignored. Thus, the issue is not one of the role of economists in general, but also one of the relative weight of comprehensive planning versus more numerous, but smaller-scale, interventions in the specific conditions of poor and small countries.

In short, consultation with economists has to be an established routine if they are to have any significant influence. Establishing such a routine where it does not exist is the principal reason for putting the economic planning service into the portfolio of a politically powerful minister who can discipline departments that ignore their economists. One would not aim at giving economists a god-like status--there is more to economic development than economics. One merely wishes to ensure that the economic analysis, such as it is, gets taken into account when decisions are made.

The precise form of organization is perhaps a matter of choice, but reasonably successful systems are so rarely found in operation that it is worth describing one that does work fairly well and, in my experience and in the experience of visiting officials from various aid agencies, is probably the most effective system in ex-British Black Africa, namely in Malawi. Not all the analysis that was done was actually fed into policy-making. Nevertheless, quite a lot did get through, and on the whole the economists probably made a worthwhile and effective contribution.

## The Position of Economists in Malawi

**The Economic Planning Division.** The system was based upon an Economic Common Service headed by a Chief Economist, who was also in charge of the Economic Planning Division (EPD) in the Office of the President and Cabinet.

The Economic Planning Division received as a matter of course copies of every project document and consultants' report emanating from ministries or state enterprises (parastatal organizations). It was represented on most committees and boards dealing with economic policy, and it was responsible for preparing, in consultation with the National Statistical Office, the Reserve Bank of Malawi and the Ministry of Finance, preliminary estimates and short-term forecasts of the national accounts and balance of payments. It also made special studies, often by request, such as projecting the demand for sugar or cement, or investigating the merits of three possible locations for a rice mill. It had neither the staff, nor the experience, nor the funds to undertake project appraisals itself, but its comments on the work of consultants and others were always regarded as an important contribution to particular debates. The two areas from which it was almost completely excluded--and probably rightly so, given its lack of expertise--were budgetary policy, which was decided under the usual shroud of secrecy by the Ministry of Finance, and monetary policy which was determined mainly by the Reserve Bank. There was quite close contact between EPD, the Bank and Treasury on most matters, but the most important issues were not always discussed with EPD.

The close integration of EPD with the policy-making machinery of other ministries inevitably meant there were considerable quantities of paper to deal with--something of the order of twenty pieces of mail per day. Some of it was routine (Government Gazette, official statistics, journals, etc.), but much of it involved work for somebody (invitations to meetings, request for information and advice, multi-volumed consultants' reports for comment and the like.) Although the volume of work was small by world standards, the office would have been unable to make a useful contribution without a routine method of dealing with the material that came in and a clear allocation of responsibility among the professional officers.

Basically, the Division was organized into four sections, called for convenience (1) Agriculture, (2) Trade and Industry, (3) Transport, (4) Social Services. The staff establishment in each section was one Senior Economist and two Economists. One Chief Economist was in charge of the Division, assisted by his deputy, a Principal Economist. The 14-man Division was never at much more than half strength in my time, and I suspect that with really well trained officers the establishment would have been excessive for the work load.

Macro-economic matters--money, banking, general fiscal policy, national accounts and balance of payments--were the responsibility of the Chief Economist and his deputy. The classification of responsibilities of the sections was exhaustive. Most jobs fell fairly obviously into one or another category; there was never any friction between sections, and there was consultation and cooperation when jobs overlapped. The existence of an establishment structure was of the first importance. Not only did it facilitate the allocation of day-to-day work, but it provided long-term staffing objectives: one knew which posts one was recruiting and training for. This fairly obvious point had not been grasped in Zambia, where years of ad hoc allocation of responsibilities had produced a very unbalanced structure of staff skills and interests.

The daily routine was simple. Incoming mail was opened and brought straight to the Chief Economist, who directed it with comments to the Senior Economist in charge of the appropriate section. It was then passed to the Principal Economist who added comments of his own, and then to the Registry, where the filing clerk put it on the appropriate file and delivered the file to the in-tray of the officer to whom the item had been directed. Every letter in government was headed with its subject to assist in getting it on the right file to the right officer. Paper passing is not an exciting subject, but there are undoubtedly offices where failure at this simple mechanical level precludes them from doing useful work.

A great merit of the system was that two people in the Division had a fairly comprehensive if superficial knowledge of the whole range of government's economic activities, and they could draw on heads of sections for details as required. Also of importance in maintaining cohesion was the 'trip file', which contained a copy of every letter (except the most confidential) that was sent out. This was circulated once a week so that all officers had some idea of what their colleagues were doing.

One of the Division's most useful roles was that of an economic information center for other branches of government and overseas visitors. Indeed, through being a center of information EPD was able, without effort or rancor, to act as a coordinator. If, for example, on receiving a proposal from the Ministry of Agriculture somebody in EPD noticed that it was related to something being done by the Ministry of Transport, a suggestion that they should get together could earn the gratitude--and future cooperation--of both parties. EPD's position was certainly not that of a controller, but it was recognized as a lubricant of the government machine and was often able to exert influence because of the fund of goodwill and confidence that it had built up. In a very unsophisticated fashion it was also a source of economic intelligence, and its budget included an allocation of funds for newspapers, periodicals and books --not on the lavish scale of the Central Bank's provision, but enough for air mail copies of The Times, Economist and the Financial Times and perhaps a score of books a year. The point would hardly be worth mentioning were it not for the fact that the Ministry of Development Planning in Zambia took nothing apart from the local daily newspapers; and the budget for the UNDP team, of around a quarter of a million dollars a year, made no specific provision for books and periodicals--indeed there was a serious shortage of Zambia's own official statistical bulletin, because there was no money to buy it.

Although it was not formally set out, the notion of a minimum list of things to be done on every job was beginning to crystallize.

Like most check lists, once stated, it looks self-evident. The minimum list can be put in the form of four questions to be set against every proposal:

1. Is it in line with general government policy--e.g. on regional development, sectoral development, income distribution, protection, etc.?
2. Do the figures look reasonable?
3. Is the economic analysis plausible?
4. Is it related to any other actual or planned activity, and if so are any modifications required on either side?

As a rule the answers to all four questions were satisfactory, but there were occasions when a major flaw was noticed. For example, on one occasion, it was observed that draft of a rail project and a road project were both basing their estimates of cost and benefits on the same traffic.

Drafting comments and participating in meetings were the routine activity of EPD, but it also performed some more general functions. It had the good fortune not to be burdened with the preparation of a big set-piece plan document every five years. It had prepared a Statement of Development Policies in 1970, which consisted of a statement of general principles that closely resembled a fairly liberal textbook on economic development, followed by sectoral and macro-economic projections up to 1980. Nobody ever referred to the figures to see if the economy was 'on course'. In terms of GDP it was quite close to the projections, although many of the sector projections were wildly astray. The projections were being revised when I left.

The main purpose of these projections was to assist in project preparation and appraisal. Consultants, ministries, government corporations or private concerns were, for example, frequently interested in forecasting demand, and as a first (and sometimes only) approximation, a coefficient of income elasticity was applied to the projected growth rate of income. The EPD projections were probably based on more complete information than was available to anyone else, and they introduced an element of internal consistency into the whole development program. But it was becoming clear that, to be of use, the projections would have to be quite long-range and therefore uncertain. Their logical status was very vague: they were based on an implicit assumption that some level of investment would occur, but investment decisions were to some extent dependent on the projections. It is arguable that, in the development process, even bad decisions are preferable to no decisons; if so, the best contribution was to speed up decision-making by putting a plausible set of projections on the shelf for reference. The absence of decisions produces uncertainty and stagnation or even deterioration, but the efforts to extricate a project from a bad decision can generate progress. A great strength of Malawi--as compared with some other governments--was that decisions were taken quickly, usually by the President. The availability of projections accelerated the preparation of projects to the point where they could be put before him for approval.

In so far as there was a plan it was a very unsophisticated one-year plan, the first year of a rolling three-year program which was presented with the budget in the Development Estimates each year. The second year's figures were rather shadowy and the third year's very tentative indeed. In fact, of course, as each year approached one found that most of the resources available were already committed to ongoing projects. Planners are never faced with a clean sheet. EPD, however, had had its say on every project, and could comment on the overall balance of each year's program.

The initiative for projects invariably came from ministries and parastatals, most of which had extensive but undated programs in outline in their files. For example, the Ministry of Works had a fairly comprehensive road network mapped out, the Ministry of Agriculture had crop and livestock schemes in outline, and the Ministry of Education knew what sort of schools it wanted and where. Each year they put up their requests for funds from the Development Budget to continue existing schemes or to embark on new ones, supported by a standard form of documentation setting out background information, objectives and probable expenditure over the next few years. Often the first that EPD would hear of a project would be when this material arrived in the mail. It would make such comments as it thought fit and the original proposals might be amended. Then, a few weeks before budget day, each ministry appeared before a committee drawn from the Treasury, the Development Division of the President's Office (which was keeping an eye on the Development Budget) and EPD. Final explanations were asked for, and at the end the Treasury and Development Division undertook the inevitable hasty cutting of estimates to fit available financial resources. In the world of theory, perhaps EPD should have been in at this final stage, arguing that the social benefit of a marginal K10,000 spent on A was greater than the same amount spent on B. In the real world, with budget day a fornight ahead and precious little information relevant to estimating marginal effects, EPD's guess could be no better than anyone else's, and it could only have looked foolish had it tried to interject esoteric considerations. With so much of the money from external sources tied to specific projects, there was not much room for maneuver anyway.

Each year the Division was responsible for preparing the Economic Report which was presented to Parliament as a budget document. The sectoral chapters were drafted in the appropriate ministry and revised by EPD in consultation with the ministry; EPD drafted the chapters on national accounts and balance of payments, and the Reserve Bank looked after money and banking. It was a severely factual document, of rather less than a hundred pages and about 80 tables, giving long runs of figures with preliminary estimates of some of the latest ones, and containing a sentence or so on the progress of every development project in the country. There was a minimum of cosmetic treatment, and then only on a few issues that might inflame the President with possibly dire consequences for someone. The figures were as reliable as they could be made. The first, and indeed almost the only aim of this exercise was to produce a compendium of factual and statistical material that would help administrators and professionals. It was widely used both inside and outside government as a first source of reference on national accounts, numbers of cattle slaughtered, retail prices, railway traffic, etc., etc. Indeed, there was a strong presumption that if an area of economic activity was not referred to in the Report, then no information was available. There were no comparisons with norms or targets, few excuses and little self-congratulation; it was about as dull and as useful as a telephone directory. A similar much smaller Mid-Year Review was produced around October giving forecasts of some figures for the current year.

These annual exercises served two very useful purposes. Firstly, they kept the Division fairly comprehensively informed about what was going on. In its capacity as editor of a parliamentary document it could obtain clarifications and explanations which might not have been forthcoming for an enquiry of its own. Secondly, the Report served as a frequent reminder of the usefulness and reliability of the Division, and earned it sufficient respect inside government for it to command a hearing on other matters. All this was in marked contrast to the comparable document in Zambia, which was much shorter, hastily prepared and contained little hard information.

Another function of the Division was to give general guidance in economic matters. For example, it circulated a fairly short set of guidelines on project appraisal. In effect, these were the U.K. Ministry of Overseas Development's condensation of Little and Mirrlees' handbook of project appraisal, further condensed and altered to suit local conditions. They helped to secure a certain amount of uniformity in the way projects were considered.

EPD also issued a short guide to business accounts in the private sector. It is a commonplace that even very good graduates in economics from very good universities usually know little or nothing about the accounts of firms, although they may be well versed in sophisticated theories. It was not uncommon for professional economists to make glaring mistakes, such as confusing a profit margin with a rate of return. Although Malawi leans in the direction of laissez-faire, it is such a small economy that a number of firms are in a monopolistic position and therefore require some degree of scrutiny and control, notably over prices. Where multinationals were involved the relationship between their accounting practices and their local tax liabilities needed watching. Applications for industrial licenses and for protection from imports also had to be vetted. In all of these areas business accounts were a relevant part of the evidence. In a country desperately short of accountants, twenty pages of elementary guidance to officers in executive ministries dealing with private firms probably eliminated a lot of gross error. The demand for additional copies of the document suggested that it supplied a need, and it was a modest attempt to improve things in an important area. Officials acting in complete ignorance of elementary accounting principles could easily put a firm out of business, or allow it to exploit the public and the government, or bring government into contempt, none of which helps the development process.

It would be very impressive if one could say that EPD determined the minimum permissible rate of return that was acceptable in a project appraisal, raising it and lowering it to ensure that all investible funds found a suitable project. There was in fact a target rate of return, 12 percent, which was set several years earlier. It was still used as a reference point and projects that fell below it were very carefully scrutinized. There were, however, a number of very good economic reasons why it was not and could not be used as an automatic control over investment decisions. Some development theories are apt to conjure up visions of a library of fully worked out investment possibilities shelved in descending order of internal rate of return--50 percent... 20 percent...3 percent. The planner, it might seem, starting at the top, simply collects enough projects to absorb all the available funds, and he then has the investment program. In fact, project preparation is a slow and often costly business, and well prepared projects are scarce in poor countries. There are often funds available either interest-free or on IDA terms of 1 1/2 percent for a project that looks like yielding 7 percent, and there is no other way of absorbing the funds in sight. If one stuck to the 12 percent rule it would be necessary to spend months, perhaps years, putting together another project and negotiating finance for it. As a rule the sensible thing to do is to take the 7 percent option.

A further reason for treating the target rate of return rather lightly was that it was very rare for agricultural projects to show anything like 12 percent. Part of the problem lay in defining costs. Should the costs of additional tube wells in villages, housing, crop extraction roads and so on be counted as product costs? It was often difficult to say whether they would have been incurred anyway under government's general program of social services, or whether the project generated extra costs in these areas. No doubt some user charges could have been devised to take care of the problem in theory; in practice it was feared that any attempt to make a significant charge for ancillary services would so reduce the level of participation that the rate of return might fall even further. There were also problems of comparability--e.g. why include a direct charge for additional roads required for rural projects while urban roads were a general charge on the community? Furthermore, it was arguable that the rules should be relaxed because rural income appeared to be so low.

Thus the target rate of return was by no means the sole criterion applied to investment decisions; and public sector investments were so lumpy in relation to the size of the economy that it would have been ridiculous to insist upon it. Nevertheless, if the target rate had ever been adjusted, EPD would have led the debate on proposed changes. Similarly with shadow prices, had they ever been used: EPA would have initiated the discussion, made known the decision, and vetted every project to ensure that they had been employed in a uniform manner. Although in the abstract a cast-iron case can be made for shadow pricing, since markets are never perfect, there was no disposition to use them in Malawi. The overall balance-of-payments position was fairly comfortable, and there was not a very severe urban unemployment problem. Thus two subjects that appear to be crucial in development theory rarely crossed the minds of the economists--except in explaining the position to visitors. Internal rates of return and net present values were calculated for projects where the cash value was of primary concern, but there was not a strict cut-off point nor did it seem sensible to have one.

The Economic Common Service. The Economic Planning Division, together with most of the economists employed in other ministries, made up the Economic Common Service. Members of the Common Service were on the establishment and payroll of the ministries in which they worked. If they were to preserve their influence as professional economists, it was of the first importance that there never be any doubt about their loyalty to their own ministry. Apart from common professional interests, the most obvious unifying element in the Service was perhaps to be found in the functions of the Chief Economist who was responsible for recruitment, training and posting.

A ministry wishing to recruit an economist consulted the Chief Economist on the nature of the post, grading and qualifications needed, and whether local or (less and less frequently) overseas recruitment was appropriate. Local recruitment was mainly arranged by talking to each year's crop of university graduates and to a lesser extent by local advertisement. When the Public Service Commission interviewed candidates the Chief Economist or his representative was present. Overseas recruitment was arranged mainly through the Malawi Buying and Trading Agents in London. The Chief Economist assisted in drafting the advertisement, reviewed the written applications and reports of interviewing panels and made recommendations, which were usually followed.

Responsibility for training was mainly exercised by keeping an eye on the courses and fellowships available and nominating members of the Service where appropriate. The training ranged from attendance at a conference, through the specialized courses in project evaluation lasting a few months at Bradford University in the U.K., to Master's courses of up to two years' duration. The sources of funds varied, but Canada and the U.K. provided most of the money and UNDP was sometimes a donor of last resort. Normally local recruits were not sent abroad for training in their first year, but they were warned on entry that they might be required to train overseas—which was sometimes but not always an attraction. The intellectual quality of local recruits was relatively high, but they sometimes had difficulty in coping with overseas courses.

Posting members of the Common Service in the various Ministries presented quite delicate problems. There was a wide variation in the number and status of posts established in different ministries, and it would have been impossible to recruit good people for employment in ministries with only one or two junior posts unless transfers for promotion were permitted; one of the functions of the Common Service was to provide a ladder of advancement. Ministries, however, were naturally averse to losing experienced officers, and it was essential to assume that officers would only be moved for good reason, and to negotiate any movements very carefully. Basically the position of the Chief Economist vis-a-vis the ministries was very weak, because, as an extreme measure, a ministry could ask for a post to be abolished. The Ministry of Agriculture, which had ten posts for economists, was barely prepared to admit that they were in the Common Service until a circular from the Secretary to the President and Cabinet determined the matter. The Ministry of Education broke its link by changing the title of the economist's post. The Ministry of Transport also ceased to use the Common Service for a time, returning when they found that they needed some supporting economic expertise. In both cases the device used was to create a post of 'planning officer' and transfer the economist to it with the inducement of a rather higher grading. The Chief Economist might appeal to the Head of the Civil Service, but it was not easy to ignore the views of the responsible head of a ministry on how he wanted to organize it.

Apart from providing a potential channel of promotion, the Common Service fostered a certain esprit de corps. Monthly meetings at which papers were read and problems discussed helped to foster a feeling of professional pride. Communication between members of the Service was almost certainly easier than would normally be the case between civil servants in different ministries. The economists played an unobtrusive part in explaining ministries to each other. In the early stages there was an element of suspicion that the Service was a kind of fifth column planted within ministries. This evaporated fairly quickly as it became clear that the economists were simply trying to do a professional job without intrigue; they were not pressing any policy of their own.

Recruitment and retention of good economists in government encountered some serious problems, which also arise in other African countries. Firstly, economists in their degree courses pick up some knowledge of the jargon, practices and objectives of commerce. They are therefore useful recruits for the private sector and parastatals, and these non-governmental employers can usually offer better pay and conditions than the civil service. Secondly, and for similar reasons, the Personnel Division looking for administrators--always desperately scarce--was liable to offer a good economist promotion to a general administrative post; in 1975, for example, the Principal Economist in EPD was promoted to Deputy Secretary in the Ministry of Trade and Industry (three levels higher), and lesser cases could be quoted. (In Zambia, where the copper mining corporations offer high salaries, the problem of retaining economists and statisticians was even more acute.) The limit of promotion for professional officers was "Superscale 5", and the Common Service only contained one such post, whereas for general administration there were numerous posts above that level. With the expansion of government and localization of posts, the excellent prospects for promotion probably attracted many of the better civil service recruits to "administrative" posts rather than professional cadres.

## Comparison with Zambian System

The merits of the system in Malawi may be illuminated by a comparison with Zambia. In Zambia there was a Ministry of Development Planning (until December 1975 a Division of the Ministry of Finance). It contained about 25 economists, only four of them Zambian, all in junior posts. Economists had been recruited on an ad hoc basis as needs were felt and, although the level of individual competence was high, far too many had specialized in the macro field. Papers for internal circulation in the ministry were produced in abundance, but there was minimal communication with the outside world. Almost the only function of the Ministry was to prepare the National Development Plan. There was no Economic Common Service. Individual economists employed in ministries were usefully occupied, but there was little professional contact between them and practically none with the so-called planners, so that there were none of the benefits which went with Malawi's network of non-planner professional economists spread across government.

In some ways the comparison with Malawi is unfair to Zambia, whose government has virtues not found in Malawi. The two countries have about the same population, 5 million, but differ in other respects, notably in the larger land area and mineral deposits of Zambia. In the early years of Zambian independence the planners in central government were undoubtedly influential. Those were the days when copper production was so profitable that its contribution to Zambia's budget and balance of payments probably exceeded the country's absorptive capacity. In 1967 the (expatriate) head of the planning office told me that their main problem was to find ways of spending all the money. By 1976, because of rising costs, falling prices and transport difficulties, the budget revenue from copper had disappeared and there was severe financial stringency. Within a few years scarcity became a real problem, and choices dictated by lack of resources had to be made. In those circumstances, ministers and officials with direct executive responsibility for projects and policies insisted that the choices be theirs, and the central planning office became superfluous. In Malawi, on the other hand, which had been poverty-stricken from the start, there was never any doubt that EPD was the handmaid of ministries which had the last word in making decisions, and it had adapted itself to that role.

There was also a difference in the degree of reliance on expatriate economists. In Zambia the more favorable employment opportunities for well educated people in the private sector, parastatals and general administration had practically denuded the government of Zambian economists and statisticians. So the staff of the planning office was almost entirely non-Zambian, none of them expecting to stay more than a few years. Malawi offered fewer alternative employments and, although a small number of people left the service, they mostly remained in the country. The usefulness of the expatriate economist is inevitably limited. He may have more technical expertise than his counterpart, but by the end of his contract he is unlikely to have acquired more than an anecdotal knowledge of the political, religious, social and ethnic structure of the country, to say nothing of its language. For an engineer or a doctor this may not matter, but for an economist involved in policy-making it is of the first importance. In Malawi there were enough local professional colleagues to save an outsider from most indiscretions.

Despite the contrast in the status of the central economic agency in the two countries, the role and usefulness of economists employed in other ministries were very similar in both countries. Sometimes they generated useful work themselves, such as comparing costs of similar activities in different places and looking for explanations that would help to improve efficiency; sometimes they were assigned specific jobs, such as advising on an application for an industrial license or comparing probable costs and benefits of different road alignments; and very often they were taken into general policy discussions. They were fully used, often overworked, and their contributions were valued. Paradoxically, there was probably more de facto coordination of economic policy in Malawi, where central planning was derided, than in Zambia, where it was ostensibly an article of faith. Membership in the Economic Common Service in Malawi encouraged communication between economists in different ministries. Each knew a good deal about what the others were doing, and this provided a useful inter-ministerial link. Economists in Zambia exchanged views and information on a personal basis, but they tended to work more narrowly within their own ministries.

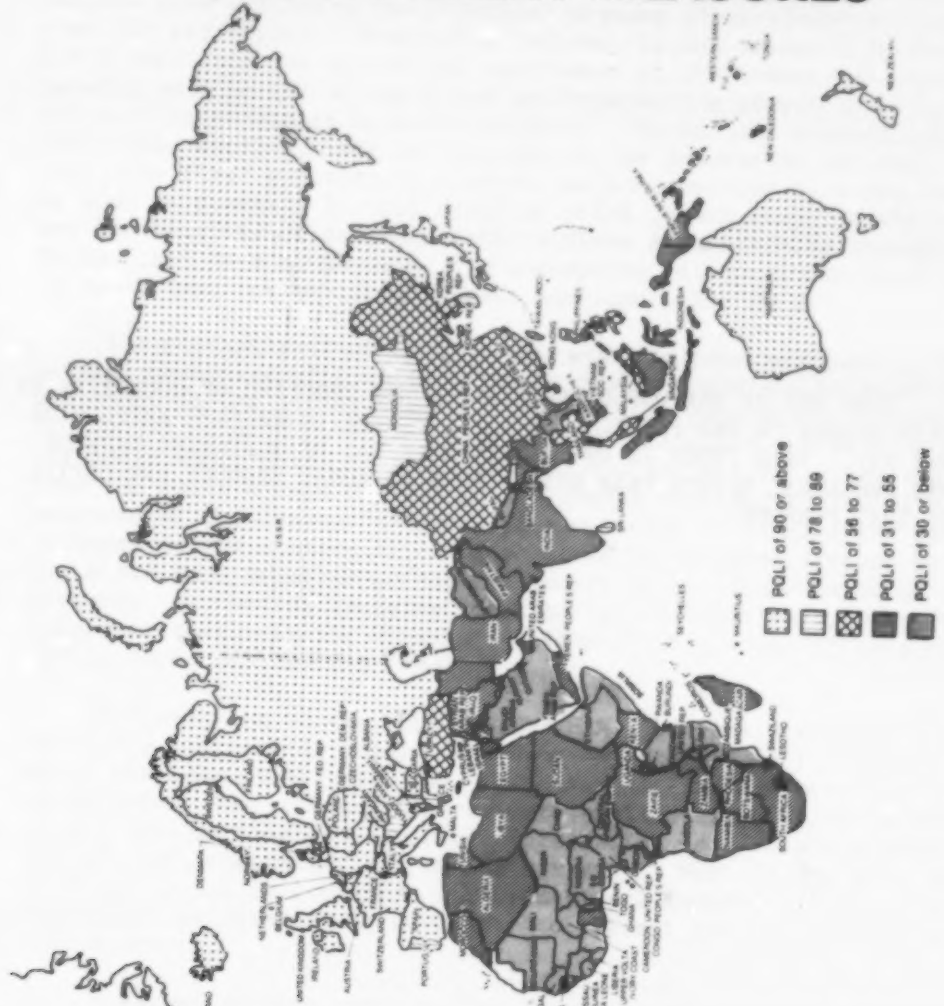
Results. Economists rarely attempt to apply cost-benefit analysis to their own services--perhaps from modesty, or perhaps from fear of the answer. In Malawi there was a constant flow of simple economic analysis and comment into the policy-making machinery, mainly but not exclusively in connection with the public sector development program, amounting to about $65 million in 1975/76. If the economists' contribution raised the rate of return by one-tenth of one percent on average, it would increase the yield of the 1975/76 program by $65,000 per year. Taking a 12 percent rate of discount and a ten-year horizon, the value of the contribution attributable to 1975/76 would be $367,000. This is almost certainly a minimum estimate, for without the project preparation section in the Ministry of Agriculture or the assistance provided to consultants large parts of the program would never have started. If the improvement in the rate of return is put at one-half of one percent, the value of the economists' contribution becomes $1.8 million for the year.

Direct cost estimates are only available for EPD. These came to about $120,000 and covered about one-third of the economists in the Common Service.. Thus the direct cost of the economic contribution was of the order of $360,000. One can be pretty sure that the Service at least provided an output commensurate with its costs, perhaps far in excess thereof.

The moral, if there is one, is that practicing economists should regard themselves, and be regarded, as ordinary workmen in the development process. They have useful contributions to make in both macro and micro fields. Experience in four small African countries suggests that if they are to make that contribution they must participate in government as a matter of daily routine on a par with the lawyers, administrators, engineers and other professionals.

[Extracted from The Journal of Development Studies, Vol. 15 No. 2, January 1979, pp. 216-232. Copyright © Frank Cass and Co. Ltd., London.]

# DEVELOPMENT MEASURES


▨ PQLI of 90 or above
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▩ PQLI of 56 to 77
■ PQLI of 31 to 55
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SRI LANKA
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SOUTH AFRICA
SWAZILAND
LESOTHO
ICELAND
UNITED KINGDOM
IRELAND
PORTUGAL
SWITZERLAND
NETHERLANDS
BELGIUM
DENMARK
GERMANY FED REP
GERMANY DEM REP
CZECHOSLOVAKIA
ALBANIA
MALTA
ARGENTINA
URUGUAY
GUYANA
SURINAM
DOMINICAN REPUBLIC
PUERTO RICO
HAITI
JAMAICA
PANAMA
COSTA RICA
EL SALVADOR
GUATEMALA
SENEGAL
THE GAMBIA
GUINEA BISSAU
GUINEA
SIERRA LEONE
LIBERIA
IVORY COAST
UPPER VOLTA
GHANA
TOGO
BENIN
CAMEROON UNITED REP
CONGO PEOPLE'S REP
RWANDA
BURUNDI
UNITED ARAB EMIRATES
YEMEN PEOPLE'S REP
MALAYSIA
SINGAPORE
INDONESIA
HONG KONG
NEW CALEDONIA
WESTERN SAMOA
TONGA
NEW ZEALAND

THIS MAP OF THE WORLD ILLUSTRATES THE GROUPING OF COUNTRIES BY THEIR SCORES ON THE PHYSICAL QUALITY OF LIFE INDEX (SEE ARTICLE ON PAGE 95). THIS INDEX IS ONE ALTERNATIVE WAY OF MEASURING DEVELOPMENT PROGRESS, RATHER THAN USING GROSS NATIONAL PRODUCT PER CAPITA FOR THAT PURPOSE.

# New Measures of Development

Anthony Pearce-Batten, Associate Editor, Development Digest

The major economic policy objective of developing countries in the postwar years has been to maximize their output of goods and services, and despite some criticism the principal measure of development progress has been GNP per capita. Developing nations, it was assumed, by and large would replicate the historical experience of the industrial countries, embarking on a period of rapid and self-sustaining growth after achieving a critical threshold of economic maturity. Social and economic disparities would then decline, much as they did in the industrial nations. Therefore, the first priority in economic development was to bring countries as soon as possible to that stage at which growth would be self-sustaining, and the benefits of progress would diffuse automatically throughout society. In the last decade, however, the assumption that progress would be certain to reach down to low-income groups has come under attack.

The perception that this process was far from automatic, and that in several countries with rapid economic growth there was no discernible improvement in the living standards of the poor population, led many to a broadening of development priorities with increased emphasis on meeting the basic human needs of the poor. As the definition of development--and thus the route toward it--changed, a search intensified for alternative measures of development progress to supplement or replace GNP per capita. To date, as the summary of the literature in the next article by Norman Hicks and Paul Streeten points out, there is no consensus on any single measure. Succeeding articles describe two alternative approaches to development measures--the Physical Quality of Life Index (PQLI), and the Social Accounting Matrix (SAM).

The analyses of the PQLI and the SAM, two very different attempts to develop a basic-needs-oriented development measure, illustrate some of the major problems which beset the search for alternative measures of progress or welfare. One problem concerns data availability. A cited advantage of the PQLI is that the necessary information is widely available although, as with GNP, the quality of the data varies. Most of the data required to construct a SAM is contained in the national income accounts, but additional survey research is necessary to collect the information on household accounts.

A second problem concerns the degree to which the development measure is an accurate reflection of the dynamics of the development process. With greater emphasis on improving distribution of benefits, there is a corresponding necessity to identify and monitor the means by which distribution is improved. Both the PQLI and the SAM reflect this need. Of the PQLI, it is argued that the concern is with welfare results, and not economic inputs, as in the GNP measure: the three PQLI elements are sensitive measures of how effectively essential services are actually reaching the population as a whole--indeed each measure purportedly monitors several different delivery systems. The SAM relies on inputs, but seeks to analyze the systemic interactions and transformations in a national economy necessary to effect a rise in the living standards of the poor.

The Physical Quality of Life Index, presented by Morris D. Morris, is a simple measure, with three familiar ingredients: literacy, infant mortality and life expectancy—and its simplicity is a major source of both its appeal and the criticism it has received. In contrast, the Social Accounting Matrix (SAM) is almost dauntingly complex. In one respect, it is a 'snapshot at one particular moment' of a national economy, which outlines the structure and nature of production, the distribution of income by households, and the composition of their expenditures. The SAM is a condensation of reality into a kind of input-output matrix, which functions within a dynamic model that simulates the interaction between the various components of the production structure, and between the production structure and income distribution. The authors emphasize that efforts to improve income distribution must necessarily consider the structural constraints, as well as the changes in production structure that such improvements would effect. Because of these interactions, they state, changes in income distribution are likely to occur rather gradually.

While most of the information necessary to construct a SAM is available, it is often ill suited for the analysis of distribution and poverty-linked issues. "The important thing is to integrate questions of poverty and inequality in the aggregate economic framework," argue Pyatt and Thorbecke. "One of our main recommendations is that work on national data systems can and should be reorganized so that planning can be concerned with poverty and inequality as well as growth." There are indications that government statistical offices in some developing countries are in fact collecting the kind of data necessary to construct a SAM, and SAMs are or have been built in at least a dozen diverse countries including Saudi Arabia, Sri Lanka, the Philippines, Malaysia, and Indonesia, raising the prospect of cross-national comparisons of policy measures. At the same time, as this issue of the Digest goes to press, both the World Bank and the United Nations Statistical Office are embarking on major programs to expand the availability of data on household and personal living standards. The UN Statistical Office is to initiate a major program to enhance national capabilities to conduct household surveys. The World Bank's Living Standards Measurement Study is to explore and assess the existing methods of measuring living standards, ranging from the conceptual links between household expenditures, welfare and the national accounts, to operational and methodological issues of measurement and data processing and storage.

# Indicators of Development: The Search for a Basic Needs Yardstick

Norman Hicks and Paul Streeten

[The measurement of development efforts in developing countries has generally focused on the growth of GNP per head and related concepts. Increasingly, development economists have felt that growth of output or income by themselves are not adequate indicators of development, and that the reduction of poverty and the satisfaction of basic human needs are goals that should show up in a measure of development. There has been growing interest in designing better measures of development, including modifications of GNP, social indicators and associated systems of social accounts, and composite indices of development, which are reviewed critically here.]

Ever since economists have tackled the development problems of the less developed countries, the principal yardsticks for measurements of economic development have been GNP, its components, and their growth. Despite the many problems with national accounting in developing countries, the national accounts have continued to be the main focus of discussions of growth, the allocations between investment, consumption and saving, and the relative influence of various sectors in total value added. GNP per head is widely accepted as the best single indicator of development, both historically and for international comparisons, despite well known problems.

The heavy emphasis on GNP, or GNP per head, and their growth rates as the principal performance test (though not necessarily as the 'objective') of welfare or development was based on doubtful assumptions. Either it was assumed that economic growth has a tendency automatically to 'trickle down' to the poor; or it was

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the World Bank, Washington, D.C.

thought that where there was no automatic tendency for the benefits from growth to spread to the poor, governments would take corrective action. Some authors insisted that concern with greater equality of income distribution, with alleviating poverty, or other social aspects of development was premature since it would reduce savings, investment and work incentives, and therefore growth.

In the light of the experience of the last 25 years, neither of these assumptions turned out to be generally valid. Highly concentrated and unequal growth was observed in some countries for prolonged periods; there was no universal tendency for growth to spread. Nor did governments always show signs of correcting gross inequalities. Doubt was cast on the need for inequality to promote growth when no correlation between unequal income distribution and high growth rates was established. Inequality and poverty were found not to be a necessary condition of growth and indeed were often an obstacle to it.

Disappointment with GNP per head and its growth as policy guides led to greater emphasis on employment and redistribution. But it was soon seen, on the one hand, that unemployment in the sense in which the term is used in the developed countries was not the problem in the developing countries. On the other hand, redistribution from growth only yielded very meager results. Furthermore, it is now clear that mass poverty can coexist with a high degree of equality, and that reductions in absolute poverty are consistent with increases in inequality. Concern has shifted to the eradication of absolute poverty, particularly by concentrating on specified basic human needs. Meeting these needs in nutrition, education, health and shelter may be achieved by various combinations of growth, redistribution of assets and income, restructuring of production, and reducing population growth. It is the composition of production and its beneficiaries, rather than indexes of total production or of income distribution, that have become the principal concern in this connection. This new focus on meeting basic human needs points to the need for an indicator or a set of indicators by which deprivation can be judged and measured, and policies directed at its alleviation and eradication can be initiated and monitored.

The problems inherent in using GNP as a measure of social welfare have been recognized almost since the inception of national income accounting. This paper identifies and reviews four different approaches to the measurement problem:

(1) adjustments to GNP, through which modifications of standard national income accounting concepts are undertaken in order to capture some of the welfare aspects of development and to improve international comparability;

(2) social indicators which attempt to define non-monetary measures of social progress;

(3) the related social accounting systems which attempt to provide an organizing framework for some of these indicators;

(4) the development of composite indices which combine various social indicators into a single index of human and social development or the 'quality of life'.

In addition to these four broad areas, efforts have been made to design an adequate measure of income distribution, and to count the numbers living below a defined poverty line. We discuss this briefly under the 'adjustments to GNP' approach rather than attempting to review the extensive literature on this subject.

Adjustments to the GNP Measure

Despite the overwhelming attention to growth, the deficiencies of GNP per head as an indicator of economic development have been apparent to many for some years. Pigou already had pointed out that economic welfare comprises not only national income per head, but also its distribution and the degree of steadiness or fluctuation over time. Measurement problems become apparent when one attempts to make inter-country comparisons of GNP per head. Part of the problem arises from the fact that official exchange rates do not measure relative domestic purchasing power, since a large portion of marketed GNP does not enter into world trade. In addition, trade policies often create distortions in nominal exchange rates, so that they fail to reflect the true value of even that proportion of GNP which is traded.

Colin Clark was one of the first to attempt in 1940 to convert national accounts using purchasing power parities. This means measuring the output of each country at a common price level, usually international prices. The most recent and complete work on purchasing power parities has been undertaken by Irving Kravis et al. The results of this research suggest that the GNP of India, for instance, should be adjusted upward by a factor of 3.5 for comparison with U.S. incomes in dollars; other countries would be adjusted by a somewhat smaller margin. Even these kinds of adjustment for the purchasing power of different currencies, however, cannot eliminate all the problems of comparing GNP across countries. For instance, because of climatic conditions greater expenditures may be required for clothing and shelter in the colder parts of the world in order to survive, while dry tropical zones require more expenditure on irrigation. Evaluations of non-tradable products, particularly public and other services, are difficult and subject to conceptual problems.

In any case a great deal of work is necessary, covering hundreds of goods and services, in order to estimate accurately purchasing power parities. Unless a short cut or reduced information method is developed, it will be difficult to make wide use of this approach.

Nordhaus and Tobin attempted in 1972 to adjust GNP so that it would be a better 'Measure of Economic Welfare' (MEW). This approach entailed subtracting from GNP an allowance for devense experditures and other "regrettable necessities," such as the "disamenities" of urbanization (pollution, congestion, crime, etc.), while adding an estimate of the positive value of leisure and the services of consumer durables. At the same time, Nordhaus and Tobin reclassified health and education expenditures as investment, rather than consumption. The final result produced a MEW for the USA that was substantially larger than GNP (about twice), largely because of the high value imputed to leisure (the measure of which raises great difficulties) and other non-market activities. The growth rate of MEW for the USA between 1929 and 1965 was somewhat lower than that for GNP, mainly because of the larger value of leisure and non-market activities in the base year (1929), reducing the proportionate rate of growth, and partly because of the growth of defense expenditure and urban "disamenities".

Denison and others have criticized this approach on the ground that GNP was never meant to measure welfare, and attempts to adjust it only confuse the concept. From the point of view of indicating the satisfaction of basic needs, the Nordhaus-Tobin corrections raise certain difficulties. 'Regrettable necessities' are subtracted from GNP, because "we see no direct effect of defense expenditures on household economic welfare... If there were no war or risk of war, there would be no need for defense expenditures and no one would be the worse without them." But similar reasoning could be applied to the components of basic needs. We do not want medical services for their own sake; if it were not for disease and accidents, we would not need to incur this expenditure. The same goes for shelter against the cold. A logically consistent application of the Nordhaus-Tobin principle would lead to an inclusion in the national income of only those items that we do not really need, the inessentials and frills, contrary to the judgment of those who wish to exclude all frivolous luxuries from our national income accounts. If it were possible to distinguish precisely between 'goods', 'bads', and 'anti-bads', we could deduct from national income anti-bads made necessary by external threats (defense), by nature (heating), by the productive system (anti-pollutants), or by advertizers (deodorants). In fact, it is not possible to distinguish between good and bad artificially created wants without introducing arbitrary value judgments, especially when applied across cultures to developing countries.

It might be possible to incorporate some of the items captured by social indicators which incorporate generally acceptable value judgments by GNP adjustments. Thus, life expectancy could be allowed for by using expected lifetime earnings instead of annual income per head or, more crudely, the product of average income per head and life expectancy. The consumption benefits of literacy could be allowed for by imputing the value of services from education as a durable consumer good, etc. (The benefits of literacy as a durable investment good already show in the form of higher productivity.) Distribution could be allowed for by taking the median or the mode rather than the mean income, thus eliminating the excessive weight given to the rich by the mean, or by multiplying the mean income by 1 minus the Gini coefficient.

Adjustment to GNP for distributional value judgments can be made by weighting different components of the national income according to who receives them. Such a redefinition would, however, eliminate the distinction between the national income and its distribution. Ahluwalia and Chenery (1974) have suggested that the growth rate of GNP in itself is a misleading indicator of development, since it is heavily weighted by the income shares of the rich. A growth of 10% in incomes of the upper 20% will have more impact on the aggregate growth rate than 10% growth (or even doubling) in incomes of the lower 20%. They suggest two alternatives: either the equal weighting of each decile of income recipients, or the introduction of 'poverty weights' which would place more weight on the growth of incomes for the lower 40%. The result is a revised aggregate growth rate which makes an allowance for differences and changes in income distribution.

Another approach would be to use simply the absolute income level of the lower 40% as the appropriate indicator to which development policies should be related. This has the advantage of shifting the focus away from the income of the well-to-do, a politically sensitive subject in many countries, to the level of living of the poor. Progress in reducing poverty can be judged, however, only if the income level of the poor can be compared with some standard minimum which reflects a 'poverty line'. The general approach adopted by many is to calculate that level of income at which the average family consumes a nutritionally adequate diet, usually defined in terms of calories. Those families (or individuals) not having this income are therefore judged to be below the poverty line, and comprise the poverty target group.

The shortcomings of this approach are many, and will be discussed here only briefly. First, examination of family income and food consumption ignores the important problem of distribution of food and other amenities within the family. It seems clear that in many countries women (who, in some societies work harder than men) and children receive less than an 'adequate' amount of food even when the family's total consumption is judged to be 'adequate'. Poverty line measures do not indicate how far families are below the poverty line so they do not show improvements that take place below this line nor suggest the condition of those brought barely above the line. They therefore conceal the efforts required to reduce poverty. A. K. Sen has proposed a weighting of individuals on the basis of how far they fall below the poverty line, thus combining poverty line and income distribution approaches.

In addition, the concept of 'nutritionally adequate' is difficult to define since caloric needs vary widely with climate, body weight and height, level of activity, age and other factors, and even for the same person in the same conditions from day to day. Household income surveys generally show that many families below the poverty line could consume an adequate diet by purchasing a different and more efficient basket of foods which are available, but which is rejected on grounds of taste, variety, etc. Families living below the 'poverty line' are often found to spend money on non-basic items such as drink and entertainment. Even with an income above the poverty line, a family may not be able to purchase essential goods and services which are in inadequate supply or controlled by the public sector (such as health, education, water supply), or they may have to rely on less efficient and more costly alternatives in the private sector (traditional healers, private water deliveries, private schools). The main basis of the basic needs approach, in fact, stems from the view that raising incomes alone is insufficient in view of the inefficiencies in the consumption patterns of the poor and the lack of availability of essential goods and services. Thus, any measure of poverty income, no matter how carefully derived, will be inadequate for measuring basic needs.

## Social Indicators

An alternative approach is to develop better indicators of human, social and economic development which cover aspects that cannot be reflected in most income-based measures. These so-called 'social indicators' attempt to measure the development of health, nutrition, housing, income distribution, as well as other aspects of cultural and social development. A great deal of work has been undertaken by various agencies to compile sets of social indicators, including the UN (1975), OECD (1976), AID (1976), UNESCO (1977) to mention only a few.

In theory, social indicators should be more useful in cross-country comparisons, since they avoid the exchange and valuation problem. In fact, the figures are often unreliable and not comparable, particularly because of different definitions used in collecting data. Many data are based on limited sample surveys or other highly inaccurate data collection methods. Differences observed in social indicators between countries often reflect these statistical and definitional variations in the indicators rather than real differences in social development. Nevertheless this constitutes a challenge to collect better, more comparable data.

Unlike the national accounts which use many prices to combine heterogeneous items, there is no obvious way to combine different social indicators. Consequently, problems arise in absorbing the content of a large number of socio-economic indicators and in any attempt to draw general conclusions. The movement to develop social indicators, furthermore, has suffered from a lack of clear perception of purpose. The term 'social indicators' has itself been used very loosely to encompass a whole range of human, economic, social, cultural and political phenomena. The need to supplement the GNP as an indicator of economic development has become confused with a search for indicators of other aspects of development, or for an indicator of the 'quality of life'. The latter concept has generally been taken to cover concepts such as security, peace, equality of opportunity, participation, and personal satisfaction, all of which present difficult measurement problems. It has never been clear whether the search was for an alternative to GNP, or a complement or a supplement.

Although we do not as yet have a unifying conceptual framework for these indicators, and despite the problems mentioned, social indicators do have certain advantages over GNP per head. First, they are concerned with ends as well as means, or at least with intermediate ends nearer to the ultimate end of a full and healthy life than are the aggregate or average production measures. Even those social indicators that measure inputs (e.g. hospital beds for 1000 population or school enrolment rates) rather than results (life expectancy, morbidity, literacy) attempt to capture inputs that are nearer to the desirable results than GNP per head.

Secondly, many social indicators say something about the distribution as well as the average, because the skewness at the upper end for income per head does not occur or is much less in these measures. There is practically no limit to how much income a man can receive, but the maximum life span is limited. (The mode or the median for income per head can, however, eliminate skewness and reflect some aspects of distribution in the average.)

Some indicators are better than others for showing also the distribution of basic needs deficiencies, since they are constructed on an either/or, have/have-not basis. Thus, measures such as literacy, access to clean water, and primary school enrolment can be used to indicate the percentage of the population having basic needs deficiencies below a defined minimum in each of these important sectors. Measures such as life expectancy, infant mortality, and average calorie consumption are less informative since they average the statistics of rich and poor alike. There seems to be a need to develop more specific measures related to the poor, such as life expectancy or calorie consumption indicators for those in the lower quintile of the income distribution, for women, for rural dwellers, etc.

Thirdly, while GNP per head follows an ascending order from the poorest to the richest countries, some social indicators are capable of catching something of the human, social, and cultural costs of opulence (the diseases of affluence like heart disease, stomach ulcers or deaths in automobile accidents), as well as poverty. They can, in principle, register some of the shared global problems, such as pollution, cultural dependence or interdependence, etc., and reduce the false hierarchical and paternalistic impression that may be created by purely economic indicators. As a result, a different meaning can be attached to the 'gap' between the so-called developed and developing countries. The GNP measure points to 'catching up' and suggests a race. Social indicators can point to shared values and problems, to alternative styles of development, to the opportunities for learning from one another. Reducing or closing the international 'gap' in life expectancy, literacy, infant mortality, or morbidity would appear to be a more sensible objective, and can be achieved at much lower levels of GNP per head and therefore much sooner, than reducing the 'income gap'.

Inputs vs. results. Whether social indicators should reflect inputs or results depends upon their purpose. For performance testing there is something to be said for choosing indices that measure results, impacts, or outputs, since these are closer to what we are trying to achieve. Furthermore, measures of inputs can introduce biases toward certain patterns of meeting needs which may not be universal. For instance, a country with fairly acceptable health standards should not be encouraged to acquire the same number of doctors as one with serious health problems. Another drawback is that the number of doctors does not measure the distribution of these doctors and their medical services, or the degree of their specialization. Resources may be deployed in inefficient ways, failing to benefit the poor. Measures such as infant mortality and life expectancy, on the other hand, indicate the degree to which medical needs have been met. In general, output measures are better indicators of the level of welfare and basic needs achievement. Some important outputs are also inputs: health, education and even nutrition are valued not only in their own right, but also because they raise the productivity of present and future workers.

Input measures, such as doctors or hospital beds per 1000 or enrolment rates in schools, on the other hand, also have their uses. They may reflect government intention, commitment and efforts to provide public services. For purposes of assessing policies and monitoring performance, both sets of indicators are necessary. Input measures are useful indicators of resources devoted to certain objectives (though these resources can be misdirected). To the extent to which we know how to link inputs to results, i.e. to have a 'production function', we can trace the connections between means and ends. Even where we do not have knowledge of a 'production function' (e.g. linking expenditures on family planning to a decline in the fertility rate), the combination of input and output measures presents the raw material for research into the causal links between the two. And where output measures cannot be readily found, it might be necessary to fall back on measures of inputs as useful proxies.

## GNP vs. Social Indices

Several studies (McGranahan *et al.*, 1972; United Nations, 1975) have indicated a high correlation between economic indicators, including GNP and social indicators. This might suggest that GNP can be used as a proxy measure of social development. Morawetz (1977) found that there was a weak correlation between the level of GNP and indicators of basic needs fulfillment, and even less correlation between the *growth* of GNP and *improvements* in basic needs indicators. Sheehan and Hopkins (1978) concluded, however, that "the most important variable explaining the average level of basic needs satisfaction is *per capita* gross national product." These contradictory results appear to arise from the use of different selection of indicators, sources of data, and country samples, as well as different interpretations of results. Many scholars include in 'social' indicators non-monetary measures of economic performance, such as newsprint or energy consumption or the ownership of automobiles and radios. These economic indicators are almost always highly correlated with GNP, and at times have been suggested as a shortcut to estimating internationally comparable income levels. Some authors exclude the developed countries, whose high levels of both GNP and social development might dominate the sample. Different results are obtained according to whether we include or exclude the centrally planned economies, the OPEC countries, and the very small LDCs.

Correlations based on 1970 data from the World Bank's Social Data Bank are shown in Table 1. The results for 7 social indicators show a modest correlation with GNP (average $r^2 = 0.50$), while a sample of 5 economic indicators show a somewhat higher correlation ($r^2 = 0.71$). However, when the social indicator data are disaggregated into samples of developing and developed countries, the correlation for both groups drops significantly ($r^2 = 0.25$ for developing countries, 0.18 for developed). Similar declines in the correlation values are also found when the economic indicators are disaggregated. Consequently, it would

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## TABLE 1: Correlation of Indicators with GNP, 1970

## (Correlation values = $r^2$)

|  | All countries | Developing | Developed | Sample size |
|---|---|---|---|---|
| *Social indicators* |  |  |  |  |
| Expectation of life at birth | 0.53 | 0.28 | 0.13 | 102 |
| Calorie consumption (as % of required) | 0.44 | 0.22 | 0.02 | 103 |
| Infant mortality | 0.42 | 0.34 | 0.25 | 64 |
| Primary enrolment | 0.28 | 0.24 | 0.05 | 101 |
| Literacy | 0.54 | 0.47 | 0.16 | 70 |
| Average persons per room (urban) | 0.58 | 0.08 | 0.29 | 34 |
| Housing units without piped water (%) | 0.74 | 0.13 | 0.36 | 36 |
| *Average** | 0.50 | 0.25 | 0.18 |  |
| *Economic indicators†* |  |  |  |  |
| Newsprint consumption | 0.79 | 0.20 | 0.46 | 85 |
| Automobiles | 0.85 | 0.59 | 0.46 | 102 |
| Radio receivers | 0.43 | 0.14 | 0.07 | 97 |
| Electricity consumption | 0.67 | 0.30 | 0.24 | 102 |
| Energy consumption | 0.82 | 0.28 | 0.49 | 99 |
| *Average* | 0.71 | 0.30 | 0.34 |  |

**Source:** **Based on data taken from the World Bank's Social Data Bank. Excludes centrally planned economies and countries with a population of less than one million.**

*** Simple unweighted arithmetic means of the $r^2$.**

**† All economic indicators are on a *per capita* basis.**

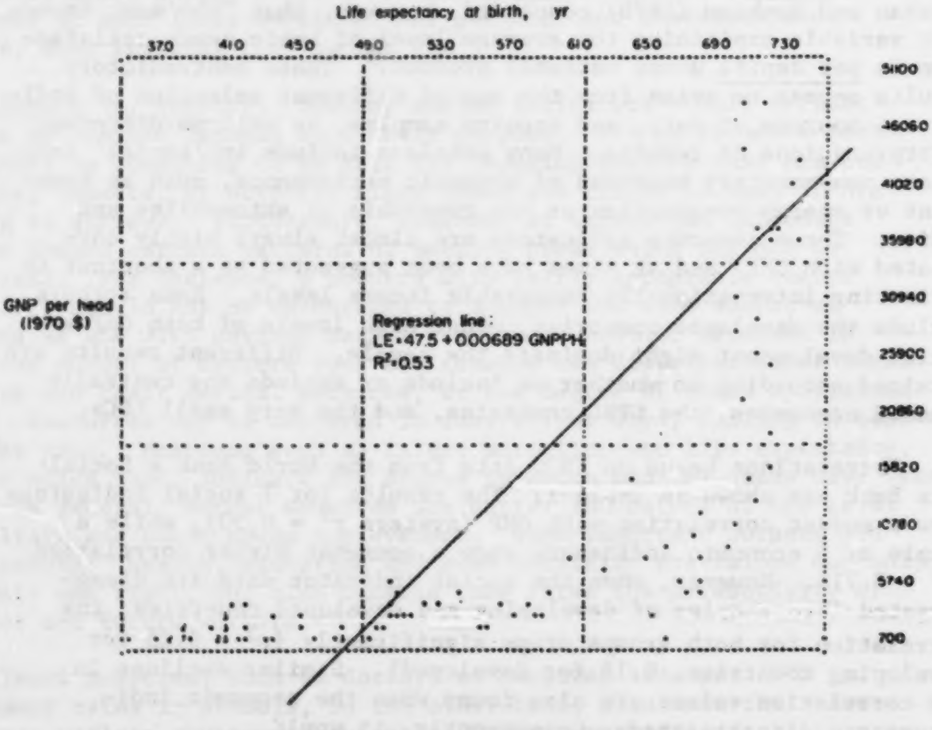

**Figure 1.** ***GNP and life expectancy*** **(1970)**

appear that studies which examine only social variables for developing countries are apt to discover a poor relationship, while those that consider economic and social variables for all countries are likely to find somewhat better relationships.

One reason why social indicators are not more highly correlated with GNP per head is that the relationships are often distinctly non-linear. Indicators such as life expectancy, literacy, and school enrolment have asymptotic limits which reflect biological and physical maxima. These limits are often reached by upper-middle-income countries, so that further increases in income show little gains in social indicators. For instance, life expectancies of 70 years of age were reached by countries with income per head in 1970 as low as $2000, while further increases do not occur as incomes increase to $5000 (See Figure 1). Similarly, most countries have attained close to 100% literacy by the time their income per head reaches the $2500 level. Conversely, countries below $500 GNP per head show a wide variety of social development which is largely unrelated to the level of GNP. Other social indicators show similar patterns. The cluster of points along either axis in Figure 1 indicates the lack of correlation at both the high and low income levels. A much better correlation could be developed using some sort of non-linear relationship; in the case of life expectancy, for example, a semi-log function increases the $r^2$ from 0.53 to 0.75. However, specification of a non-linear function would obscure the fact that strong correlation exists only among the middle-income countries. Rankings of countries by social indicators and GNP may often be very similar, but GNP per head is likely to be a misleading indicator of social development and progress in meeting basic needs, particularly when used in some linear fashion.

## Social Accounting Systems

Some work has been done on developing a system of social accounts to provide a kind of national accounting framework for social indicators. Stone (1975) and Seers (1977) have proposed the use of lifetime activity sequences calculated by dividing total life expectancy into segments. Such tables would show the average years (or fraction of his life) a person could expect to spend in various mutually exclusive states. One such matrix could divide lifetime activity between school, work, leisure, retirement, etc., while another might be built on a marital sequence (single, married, divorced, widowed). Such tables would combine various important social statistics from different fields, and would be used to indicate changes over time, either actual or planned. The system presents many problems, not the least of which is its inability to incorporate fully all aspects of social development. Some indicators (income distribution, security, policy protection, pollution) cannot be readily transformed into segments of life expectancies. Furthermore, the system goes far beyond the data available in most countries, and is thus more suited for the industrialized countries.

Other ideas have been developed for a more limited social accounting approach. The Social Accounting Matrix (SAM) of Pyatt and Round (1977) expands the traditional input-output table into a matrix which details payments made by productive sectors to different income recipients. Recipients can be disaggregated in various ways so as to indicate the distribution of income between various factors, urban/rural households, or income classes. The power of the SAM approach is that it integrates production and income distribution data in a way that gives a better view of the economy, and of the flows between sectors. It still relies, of course, on the use of GNP as a measure of welfare, and is limited in its application by the absence of good income distribution data. Terleckyj (1975) has developed a matrix framework for analyzing the impact of government programs on various social goals, as indicated by the appropriate social indicators. Since programs affect more than one social goal, the approach develops a matrix of inputs and outputs, and suggests the possibility of defining the most efficient set of programs for achieving a particular set of goals.

## Composite Indices of Development

Relatively more work has gone into developing composite indices that could be used to replace or supplement GNP as an indicator of social, economic or general development. A large amount of work was undertaken by the UN Research Institute for Social Development (UNRISD) during the 1960s to develop better social indicators, including composite indicators. For instance, Drewnowski and Scott (UNRISD, 1966) developed the Level of Living Index, which was defined as "the level of satisfaction of the needs of the population as measured by the flow of goods and services enjoyed in a unit of time." The Level of Living Index itself, however, goes beyond the provision of goods and services, and considers "Basic Needs", subdivided between physical needs (nutrition, shelter, health), and cultural needs (education, leisure, security). 'Higher Needs' or 'Surplus over Basic Needs' is taken as the surplus income over some minimum level. The 'basic needs' part of the index calls for data which are very difficult to obtain for many countries, such as the amount of leisure time available, the number of people in possession of private saving, and the quality of housing. This makes the application of the index very difficult, and Drewnowski and Scott were forced to use short-cut approximations even for their limited sample of 20 countries. Furthermore, the work, once begun, was not continued after 1966 in the same form.

McGranahan *et al.* (UNRISD, 1972) examined 73 indicators which covered economic and social characteristics, and found that there was fairly high inter-correlation between these indicators. Through a process of elimination, he constructed a Development Index based on 18 'core indicators' which included 9 social and 9 economic indicators. The resulting index was highly correlated with GNP per head ($r^2 = 0.89$), although there were some countries (Venezuela, Chile, Japan) whose ranking was substantially different under the index. In general, the correlation of the index and GNP per head was somewhat lower for developing than developed countries. This study concluded that social development occurred at a more rapid pace than economic development up to a level of about $500 per capita (1960 prices). Some of these results are themselves, however, a product of the method employed, whereby the selection of 18 'core indicators' was based, in part, on their having high intercorrelations with the other indicators. The UNRISD team found, for instance, that the country rankings remained virtually unchanged when the number of indicators was reduced from 18 to 10.

A study by the United Nations-ECOSOC in 1975 sought to analyze development by ranking 140 countries by seven indicators other than GNP. These included two social indicators (literacy, life expectancy) and five economic indicators (energy, manufacturing share of GDP, manufacturing share of exports, employment outside agriculture, number of telephones). An overall rank for each country was calculated by giving equal weight to the ranks under each separate indicator. Arranging the results by quintiles, and comparing with GNP, the UN indicated that the overall index was closely associated with the ranking by GNP. A similar study by the OECD Secretariat (1973) used regression techniques for six variables to establish a predicted GNP per head index for 82 developing countries. A more recent paper by the OECD/DAC (1977), however, concluded that "*per capita* GNP still appears to be the best measure" of the level of development.

A more recent study of the use of a composite index has been undertaken for the Overseas Development Council (ODC) by Morris D. Morris [see next article]. Morris's Physical Quality of Life Index (PQLI) uses three simple indicators with equal weights to attempt to measure the fulfillment of 'minimum human needs': life expectancy at age one, infant mortality, and literacy. Morris argues that the use of indicators for judging performance under basic needs criteria should concentrate on indicators of outputs or results rather than inputs. Input measures, he feels, do not measure success in meeting the desired goals, and may lend an ethnocentric bias to the means employed. The use of only three indicators based on widely available data permits the calculation of the PQLI for a wide range of countries, and facilitates the examination of changes in the index over time.

The weighting system of the PQLI is arbitrary, however, as there is no rationale for giving equal weights to literacy, infant mortality and life expectancy at age one. It is not possible to prove that the PQLI gives a 'correct' index of progress on human needs, as opposed to some alternative index having different weights or a different selection of component indices. It is not clear what is gained by combining the component indices with a weighting system that cannot be defended. While Morris' index has received much attention in the popular press, most scholars find it difficult to accept the results of a composite index without a stronger theoretical foundation.

Despite the potential attractiveness of having a single index of socio-economic development, there is little theoretical guidance to govern either the choice of indicators, the correct scaling of component indices, or the appropriate weights. Moreover, any index that relies only on ranking neglects the distance between ranks. Scaling problems arise when raw data on social indicators are converted into component indices ranging from 0 to 100. For instance, a reasonable range of values for life expectancy could be either 40-75 or 40-100 years. A country with a life expectancy of 60 years will obviously have a different 'score' depending on the scaling chosen (57 or 33), and this will materially change the composite index. Furthermore, the scaling system need not be linear. Drewnowski used "expert opinion" to derive a linear scale system reflecting set levels of basic needs satisfaction. McGranahan et al. developed an elaborate system of "correspondence points" to determine the appropriate scale range, and utilize non-linear (logarithmic) scaling for many indicators. Morris simply took the range of the data for each indicator with the 'worst' country being defined as zero and the 'best' as 100.

There is an even more difficult problem in the proper weights to be used for combining component indices into a composite. Drewnowski tried both equal fixed weights and a system of sliding weights under which deviations from the normal were given more weight than indices close to the normal. The shift in the weighting system did not materially affect the country rankings, which were highly correlated with the rankings of countries by GNP per head. McGranahan's weighting system gave greater weight to the component indicators that had the highest degree of inter-correlation with the other indicators, a somewhat dubious method. One would think that the absence of correlation would be at least an equally valid criterion. He also found that moderate changes in the weighting system did not affect the level of each country's index, or its ranking; this is a logical result of having high inter-correlations among the components, since high correlation implies that any one component is a good substitute for any other. The UN-ECOSOC study gives equal weight to the country ranks of the social indicators, thus avoiding, in a certain sense, the scaling problem. As mentioned above, the PQLI gives equal weight to each of the three components without ascertaining if this implies the correct 'trade-off' between the various components. None of these studies indicates that much effort was devoted to developing a theoretically sound rationale for the weighting system.

Because of these problems, it might well be argued that a composite index is either unnecessary, or undesirable, or impossible to construct. It is unnecessary if the components are correlated with one another, because then any one of the component indicators by itself will serve as an adequate index. If, on the other hand, the components move in different directions in cross-country comparisons and time series, any single index value could be regarded as an undesirable obscuring of important issues. To have the same index for a situation in which mortality is high and literacy low as for one in which literacy is high and mortality low, for example, seems to imply an equal 'trade-off' between the particular differences in literacy and life expectancy. Unless the basis for such an evaluation can be established, all weighting remains arbitrary and misleading, and composition is impossible. The case for considering the two indices separately is the same as the case for having an index independent of GNP.

If the interpretation of basic needs were taken to mean that all such needs, being 'basic', would have to be met together, so that trade-offs between different basic needs were ruled out, a composite index would not be necessary. As long as the 'package' of basic needs has not been fully met, no amount of additional satisfaction of any one component could compensate for the slightest deficiency in any other, so that a composite indicator would be ruled out. And once all basic needs had been met, again no composite index would be required. But we are not advocating such a literal interpretation of 'basic needs'.

## Conclusions

The current discussion of basic-needs-oriented development focuses on the alleviation of poverty through a variety of measures other than merely redistribution of incremental output. Such a focus supplements attention to how much is being produced by attention to what is produced, in what ways, for whom and with what impact. Obviously, the rapid growth of output will still be important to the alleviation of poverty, and GNP per head remains an important figure. What is required are some indicators of the composition and beneficiaries of GNP which would supplement the GNP data, not replace them. The basic needs approach, therefore, can be the instrument for giving the necessary focus to the work on social indicators.

As a first step, it might be useful to define the best indicator for each basic need. At present, the essential basic needs may be considered to cover six areas: nutrition, basic education, health, sanitation, water supply, and housing and related infrastructure (see Streeten and Burki, 1978; this list is not intended to be exhaustive, nor do all needs listed have the same status--ore might, for example, wish to add transportation and energy). Because there are six basic needs, there need not necessarily be only six core indicators; more than one indicator may be necessary to measure progress adequately in any one area, while one indicator may serve more than one basic needs sector.

The problem of selecting the appropriate index in each field is best taken up by technical experts in each sector. However, to give a preliminary indication of the indicators which might be included, the following have been identified:

Health: - Life expectancy at birth;
Education: - Literacy
- Primary school enrolment (as percent of population aged 5-14);
Food: - Calorie supply per head or calorie supply as a percent of requirements;
Water supply: - Infant mortality (per thousand births)
- Percent of population with access to potable water;
Sanitation: - Infant mortality (per thousand births)
- Percent of population with access to sanitation facilities; and
Housing: - None.

The core indicators identified here attempt to follow the philosophy of stressing measures of results rather than inputs. Infant mortality is assumed to be a good indicator of the availability of sanitation and clean water facilities because of the susceptibility of infants to water-borne diseases, and data on infant mortality are generally more readily available than data on access to clean water. While literacy is a good general measure of progress in education, the percent of the relevant age group enroled in primary school is also included to measure country effort. Input measures have also been identified for water supply and sanitation as supplementary measures. It has not been possible, however, to identify a satisfactory measure of housing needs. The only readily available indicator is people per room, but this really does not capture much of the quality of housing, only the number of rooms which in turn is a very rough index of crowding. Ideally, these indicators should be supplemented by data about distribution of calories per head, etc.

If an acceptable system of weights could be developed, it might be possible to combine the core indicators into a composite basic needs index. The chances of an acceptable system of weights being developed, however, are extremely small: despite considerable research, no one has come close to developing a rational weighting system. Some may question the desirability of such a composite index, even if it could be constructed with an acceptable rationale.

Instead of attempting to develop a composite index of basic needs, a useful alternative may be to narrow the range of indicators to one or two which correlate highly with basic needs fulfillment. This approach would serve the need of those who desire a single number for making quick judgments on social performance, without introducing the problems of weighted composite indices. The prospects for doing this are enhanced considerably by the fact that many of the so-called 'basic needs' are, in fact, inputs rather than ultimate goals. Certainly nutrition, water supply and sanitation are valued because they improve the health status of the population. To a more limited extent, this is also true of housing and education. All of these can be considered to be inputs into the health 'production function'. They may be valued for reasons other than their influence on health status, but a high association between the various core indicators can be traced to their impact on health. Therefore, it could be argued that some measure of health, such as life expectancy at birth, would be a good single measure of basic needs.

In a sense, life expectancy is a kind of weighted composite of progress in meeting physiological basic needs. It has the advantage of capturing the impact on individuals, not only of non-market factors but also of income net of taxes, transfer payments and social services, without raising all the difficulties of income per head measures such as the appropriate unit (individual, household or family), the appropriate magnitude (capital, consumption, income), the appropriate set of prices (market prices, international prices), what to value as final goods and what as costs, etc. For many purposes it might be regarded as superior not only to a composite index of social indicators but also to GNP and to indices of income distribution. It is possible for two countries to register the same GNP per head and the same ratio of income accruing to the bottom 20%, and yet to have different average life expectancies. (For some purposes, e.g. if life expectancies cluster very near one another, it would be useful to add a measure of progress in education, such as literacy.) It is, of course, possible to have a long and miserable life, and one might wish to put an upper limit to the desired life span. But at low income levels, there is a high correlation between morbidity and mortality.

In using a single indicator, it is, however, important to guard against two dangers: the danger to interpret the *result* in a uni-dimensional way, and the danger to interpret *inputs* in a unidimensional way. Life expectancy can be increased by measures that affect different age groups differently. Improved nutrition, for example, may affect life expectancy above one year, whereas women's education may affect infant mortality. The second danger is that the improvement of a health indicator like life expectancy will focus too much attention on health measures generally, and doctors, clinics and nurses specifically, whereas the 'production function' for life expectancy may include a number of thrusts not obviously related to health, like improved jobs, earnings, environment, etc. Just as we now know that reductions in the rate of population growth are not simply functions of improved family planning, so improved health and longer life are not simply functions of improved health delivery systems. But as long as the indicators are not identified with uni-dimensional results or uni-causal remedies, there is much to be said for a simple system of recording and monitoring.

[Extracted from "Indicators of Development: The Search for a Basic Needs Yardstick," *World Development*, Vol. 7, No. 6, June 1979, pp. 567-580. Copyright © Pergamon Press Ltd., Oxford, England.]

## SELECTED REFERENCES

Ahluwalia, M. and H. Chenery, 'A conceptual framework for economic analysis', in Hollis Chenery *et al,* (eds.), *Redistribution with Growth* (London: 1974).

Baster, Nancy, 'Work on development indicators by national governments, research institutes and individual scholars: a selective review and discussion of issues and problems' (Tokyo, Japan: United Nations Univesrity, May 1977).

Drewnowski, Jan and Wolf Scott, 'The level of living index', United Nations Research Institue for Social Development, Report No. 4 (Geneva: September 1966).

Kravis, Irving et al., *International Comparisons of Real Product and Purchasing Power* (Baltimore and London: Johns Hopkins University Press, 1978).

Olsen, Mancur, 'The treatment of externalities in national income statistics', in Lowdon Wingo and Alan Evans (eds.), *Public Economics and the Quality of Life* (published for Resources for the Future and the Center of Environmental Studies; Baltimore: Johns Hopkins University Press, 1977).

Seers. Dudley, 'The meaning of development', *International Development Review*, Vol. II (December 1969).

UNESCO, *The Use of Socio-Economic Indicators in Development Planning* (Paris: UNESCO Press, 1976).

# The Physical Quality of Life Index (PQLI)

Morris D. Morris

[The index described here supplies a comparison among countries in their progress in extending health, sanitation, education and other benefits to their populations. The formation of the index, its relation to other measures, and some of the results of applying it are presented.]

In response to disappointment with the perceived results of the growth-oriented strategies of the past quarter century, both rich and poor countries are exhibiting a renewed interest in the possibility of meeting the minimum human needs of the world's poorest people. Some see equity as a desirable objective to be achieved even at the cost of some growth. Others recognize it as a necessary, although not sufficient component of any humane growth strategy.

Whether such strategies are to be enduring or a fad, whether their objectives are serious targets or slogans, they pose as never before the need to measure not only total economic output and the composition of that output, but also how economic benefits are distributed. There never has been an easy way to measure this type of performance. Gross national product (GNP) is the most widely accepted measure of progress. However, while per capita GNP measures general economic performance within and among countries, it is unable to show how output is distributed among people in poor (or even in rich) countries. To the extent that development planners within poor countries and aid dispensers in donor countries now focus more directly on projects that emphasize distribution of benefits, they need not

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only new planning strategies but also additional measurement systems.

## Choosing the Indicators

Six criteria that a measure of international socio-economic performance should meet are the following:

1. It should not assume that there is only one pattern of development.
2. It should avoid standards that reflect the values of specific societies, i.e. avoid ethnocentricity.
3. It should measure results, not inputs.
4. It should be able to reflect the distribution of social results as well as their levels.
5. It should be simple to construct and easy to comprehend.
6. It should lend itself to international comparison.

A number of factors make life expectancy, infant mortality, and literacy appropriate indicators for measuring physical well-being and assessing progress toward identifiable targets. Although data on these three social indicators still are uneven in quality--especially in many developing countries--they are widely available. A further major advantage of these indicators is that they measure development results rather than inputs. Being relatively un-ethnocentric and objective, they are reasonable standards for performance comparison. Life expectancy at age one and infant mortality can be good indicators of important aspects of social progress, since they represent the sum of the effects of nutrition, public health, income, and the general environment. At the same time, the two indicators reflect quite different aspects of social interaction. Preliminary work suggests, for example, that infant mortality is a sensitive surrogate for the availability of clean water, the condition of the home environment, and the well-being of mothers, while life expectancy at age one reflects nutrition and general environmental characteristics outside the home.

Literacy, too, is a useful indicator, because it is both a measure of well-being and a skill that is important in the development process. The extent to which poor groups are literate helps determine the extent to which they do share, or will be able to share, the benefits of economic growth; how widespread literacy is also provides a good indication of the position of women in society. Moreover, literacy does not become widespread without sufficient advancement in a society to make it a widely desired skill.

## Creating a Composite Index

Having determined three indicators that meet the six criteria, how can these different measures--life expectancy at age one, infant mortality, and literacy--be combined into a single measure? The PQLI is based on a simple indexing system. For each indicator, the performance of individual countries is placed on a scale of 0 to 100, where 0 represents an explicitly defined "worst" performance and 100 represents an explicit "best" performance. Once performance for each indicator is scaled to this common measure, a composite index can be calculated by averaging the three indicators, giving equal weight to each of them. The resulting Physical Quality of Life Index thus is scaled automatically on a range of 0 to 100. Some countries have data that go back a very long time, while for many countries the data are still unsatisfactory. Comparative national data on a worldwide scale only began to become available in the 1950s, after the formation of the United Nations. The bottom and top limits for the PQLI indicators are based on these post-1950 data.

Indexing the indicators. The task of placing historical experience on a scale of 0 to 100 is different for each indicator. Basic literacy, of course, poses no problem. Data are reported as a percentage of the population fifteen years and older who are literate; the percentage figures correspond to the index numbers.

The scaling of the other two indicators, however, is not quite as simple. Infant mortality is expressed as the number of infant deaths per thousand live births. The worst conceivable situation would be one in which every child died within the first year--that is, an infant mortality rate of 1,000. The best situation would be on in which no person died within the first year--an infant mortality rate of 0. This range of 0 to 1,000 would allow for easy conversion to a scale of 0 to 100. However, a scaling that leads to the concentration of all the observations within a very narrow part of the 0 to 100 range will not show the rank, spread, and cluster effects that it is desirable to emphasize. Gabon's infant mortality rate of 229 deaths per thousand live births is the worst recorded by the United Nations for any country since 1950. It makes sense to exclude from the index that portion of the range that is not needed to express current, recent, or probable rates. So the worst infant mortality on record since 1950 (229 per thousand) is assigned the value of 0 on the 0 to 100 scale. The best infant mortality achieved to date has been 8 per thousand, in Sweden. Medical authorities doubt that any nation can achieve much better performance in its infant mortality than this in the foreseeable future, certainly no better than 7 deaths per thousand by the year 2000; thus 7 deaths per thousand is the high (100) end of the scale. Using a range of 229 to 7 deaths per thousand means that a 2.22-point change in the infant mortality rate will show up as a 1-point change in the infant mortality index. If a country were engulfed by a great social catastrophe that raised its infant mortality above 229, the index would have to show the result as a negative number. This does not seem likely for more than a few, relatively small countries.

The lower and upper limits of life expectancy at age one were established similarly. With data for life expectancy at birth and for infant mortality, it is possible to calculate life expectancy at age one. The lowest reported life expectancy at age one for the entire post-World War II period is 38 years for Vietnam in 1950. This figure is used as the low (0) end of the life expectancy index --even though this poses the possibility of encountering a negative number for this indicator some time in the future. The upper limit of the average life expectancy at age one index was determined on the basis of the best available estimates of what average life expectancy at age one is likely to be at the end of the century under the best national conditions. It is widely agreed that large improvements in longevity will only occur if there is a general breakthrough in the study of geriatrics. On the basis of a survey of scientific expectations, it is reasonable to set the upper limit of achievable life expectancy at age one at 77 years, two years above the current best (Sweden, with 75 years). This means that a change in life expectancy of .39 years will result in a one-point change in the index.

Thus the range for each index was based on an examination of the best and worst in historical experience, modified by expectations of possible change. The life expectancy at age one index ranges from 38 to 77 years; the infant mortality index ranges from 229 to 7 per thousand live births; the literacy index ranges from 0 literacy to 100 percent literacy. Table 1 shows for three countries how these indicators were changed to index numbers, and then averaged (equally weighted) to form the PQLI value.

The PQLI is comprised of three indicators that have no obvious relationship to each other. Each provides important information about the social process. Each was selected because it met established criteria. The PQLI is a summation of complex social interrelationships for which there is as yet no theoretical explanation that imposes or even suggests any set of weights. Because there is no reason to treat any one indicator as more important than another, equal weight was assigned to each of the components of the composite index.

Because it sets fixed lower and upper limits, the PQLI measures only movement in relation to those fixed limits. Unlike per capita GNP, the PQLI seeks to measure only a very specific type of performance for which there is an upper limit of achievement. As country performance moves close to the top of the index, there is less to measure. For example, Sweden (with a PQLI of 97) is the best provider and Guinea-Bissau (with a PQLI of 12) the poorest provider of the social results measured by the PQLI. There is only a slight range for improvement in Sweden: literacy is virtually universal, infant mortality is extremely low, and life expectancy is long and close to a society's attainable maximum. In effect, Sweden and a number of other developed countries--there are eight countries with PQLIs of 95 or more--have been able to cope with most of the specific problems which the PQLI measures. Their current social tasks are different, and the PQLI cannot measure their progress in solving the particular problems that face them.

### TABLE 1

### LIFE EXPECTANCY AT AGE ONE, INFANT MORTALITY, AND LITERACY AND THEIR INCORPORATION INTO PQLI VALUES

(Actual Data and Index Numbers, early 1970s)

| | Life Expectancy at Age One | | Infant Mortality | | Literacy[3] | | PQLI[4] |
|---|---|---|---|---|---|---|---|
| | (years) | Index Number | (per 1,000 live births) | Index Number | (%) | Index Number | |
| Nigeria | 49 | 28 | 180 | 22 | 25 | 25 | 25 |
| India | 56 | 46 | 122 | 48 | 34 | 34 | 43 |
| United States | 72 | 88 | 16 | 96 | 99 | 99 | 94 |

[1] Years of life expectancy are converted to an index number according to the formula:

$$\frac{\text{life expectancy at age one} - 38}{.39}$$

[2] The infant mortality rate is converted to an index number according to the formula:

$$\frac{229 - \text{infant mortality rate per thousand}}{2.22}$$

[3] Literacy index numbers correspond to the actual data.

[4] Average of life expectancy at age one, infant mortality, and literacy indexes (equally weighted).

Countries with low PQLIs will improve their literacy, infant mortality, and life expectancy performance. The gap between where countries are and what is possible will narrow. As these specific social objectives are realized, the PQLI will be "used up." However, it is probable that a number of generations will pass before the majority of the world's people will be living in countries where the PQLI level is so high as to render it useless.

## Correlations among PQLI, Its Component Indicators, and GNP

Does the PQLI show anything not revealed by per capita GNP? That is, do the two measures move together in a way that allows GNP to serve as a surrogate for the PQLI? Similarly, does any one component of the PQLI correlate so perfectly with the PQLI as to be an adequate substitute for the composite measure? In effect, is there any need for the PQLI?

The PQLI emerged partly as a device to identify non-typical or deviant performers--particularly those countries with low per capita GNP and high PQLI performances--whose experience might yield some insight into novel ways of improving life-quality results more rapidly than could be expected on the basis of typical assumptions about its relationship with GNP. For this purpose, only a perfect correlation between per capita GNP and PQLI would be enough to justify dropping the PQLI. In fact, however, the correlation between the log of 1970-75 per capita GNP and PQLI for all 150 countries implies that GNP "explains" only slightly more than half the life-quality results countries have been able to achieve, leaving the rest to be "explained" by other--institutional, historical, and structural--factors. The correlation, not all that strong overall, falls to low levels within income groups of countries (see Table 2). Figure 1 illustrates the relationship on a semi-log graph. In effect, per capita GNP is not a very good predictor of PQLI performance and cannot serve as a surrogate for it.

The other question is whether any one component is sensitive enough to reflect the behavior of the composite PQLI. The correlation coefficients of individual components with PQLI and GNP and with one another are also shown in Table 2. The correlations among the three indicators are high for all 150 countries as a group. Within income classes, however, this is true only in the group of countries having per capita incomes of $2,000 or more. The data do not suggest that using only one of the indicators would adequately represent the others. The correlations between the individual indicators and the PQLI for all 150 countries together are high, but again they are somewhat lower for each of the income groups separately except the high-income group. Thus, for the developing countries, at any rate, the PQLI does provide additional information.

A final question is whether the work of Irving Kravis and others that seeks to eliminate exchange rate distortions and to re-price countries' economic activity more realistically, closer to the real purchasing power of incomes in different countries, brings their revalued per capita GNPs closer to relative PQLI values. Table 3 shows that the adjustment for purchasing power parities does result in a higher correlation between GNP and PQLI

## TABLE 2

### Correlations[a] of PQLI with GNP, of Component Indicators with PQLI, with Per Capita GNP, and with Each Other, By Country Income Groups,[b] Early 1970s.

| | Low Income | Lower Middle Income | Upper Middle Income | High Income | All Countries | All Countries |
|---|---|---|---|---|---|---|
| Correlations of PQLI with Per Capita GNP | | | | | | |
| | .202 | .126 | .404 | .116 | .729 | |
| Correlations of Components with PQLI Values | | | | | | with per Capita GNP |
| LE (Life Expectancy age one) | .818 | .921 | .854 | .974 | .962 | .754 |
| IM (Infant Mortality) | -.866 | -.944 | -.928 | -.991 | -.975 | -.714 |
| L (Literacy) | .889 | .906 | .941 | .986 | .968 | .680 |
| Correlations of PQLI Components with Each Other | | | | | | |
| LE - IM | -.586 | -.819 | -.768 | -.964 | -.919 | |
| LE - L | .587 | .776 | .707 | .930 | .897 | |
| IM - L | -.864 | -.779 | -.798 | -.963 | -.919 | |

[a] Correlation Values = R, not $R^2$

[b] Low Income under \$300, N = 42
Lower Middle Income \$300-\$699, N = 38
Upper Middle Income \$700-\$1,999, N = 32
High Income \$2,000 and over, N = 38
All Countries - N = 152

## TABLE 3

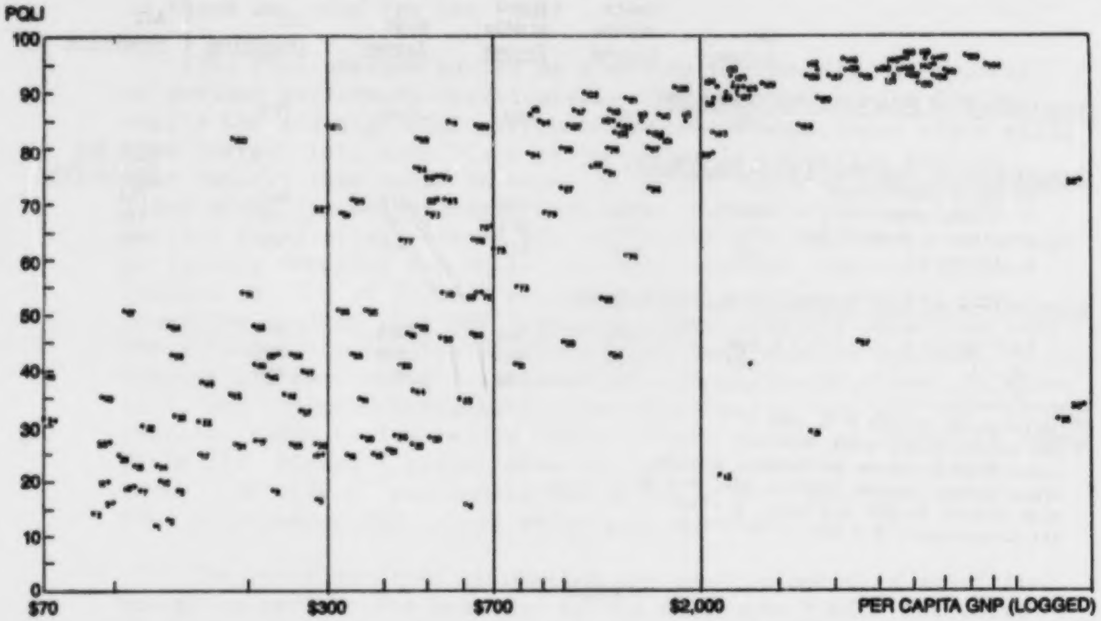
### Correlation of PQLI with Per Capita GNP and with Repriced Per Capita GNP (114 Countries)

| | Per capita GNP, 1970-75 average (logged) | Repriced Per capita GNP, 1970 (logged) |
|---|---|---|
| World (N=114) | 0.79 | 0.84 |
| Low-Income Countries (N=35) | 0.17 | 0.46 |
| Lower Middle-Income Countries (N=28) | 0.24 | 0.10 |
| Upper Middle-Income Countries (N=22) | 0.45 | 0.71 |
| High-Income Countries (N=29) | 0.28 | 0.67 |

SOURCE: Per capita GNP data (1970-75 average) are from Appendix A. Repriced per capita data (1970) are from Irving B. Kravis, Alan W. Heston, and Robert Summers, "Real GDP Per Capita for More than One Hundred Countries." *The Economic Journal*, Vol. 88 (June 1978), Table 4, pp. 232-37. The 114 countries are those for which data are available in both sources. Countries are classified by income groups as in Appendix A.

FIGURE 1

Scatter Diagram Showing PQLI and Per Capita GNP (logged) Distribution, early 1970s



for all but the anomalous lower-middle-income countries. Yet there still remain substantial differences between GNP and PQLI that even re-priced GNP does not "explain." The re-pricing technique is costly and time-consuming, even when shortcuts are employed. If some combination of re-pricing and income distribution analysis should produce a high enough correlation between GNP and POLI, it might be useful to regard the POLI as an inexpensive surrogate for adjusted GNP. However, some significant gap between the two measures will probably persist because they actually measure different things.

What the PQLI Shows

"Money is not everything." Generally, the poor countries with low per capita GNPs tend to have low PQLIs, while high-income countries tend to have high PQLIs (see Table 4). But deviations exist at all levels of income, particularly at the upper and lower ends of the per capita income range.

TABLE 4

Average Per Capita GNP and PQLI for 150 Countries, by Income Groups, early 1970s
(weighted by population)

| Income Groups (Per Capita GNP) | No. of Countries | Total Population (millions) | Average Per Capita GNP ($) | PQLI Average |
|---|---|---|---|---|
| Low-Income (under $300) | 42 | 1,242 | 155 | 40 |
| Lower Middle-Income ($300-$699) | 38 | 1,081 | 340 | 67 |
| Upper Middle-Income ($700-$1,999) | 32 | 417 | 1,047 | 68 |
| High-Income ($2,000 and over | 38 | 1,040 | 4,404 | 92 |
| All Countries | 150 | 3,781 | 1,476 | 65 |

At one end of the spectrum, the oil producers of the Middle East--most particularly Saudi Arabia, Qatar, and the United Arab Emirates--and Libya, stand out with high per capita GNPs and low PQLIs (see Table 5). Of these high-income oil states, only Kuwait has a relatively high PQLI of 74. Four of the five countries have incomes equal to or above the average of all high-income countries; yet three have PQLIs below the average of the poorest countries--and Libya's PQLI is only marginally higher than that of the low-income countries. Other gross deviations in which PQLI is quite low relative to GNP include Angola, where per capita GNP is $601 and PQLI is 16, and Gabon where per capita GNP is $2,123 and PQLI is 21. Although Iran has a per capita GNP ($1,260) more than nine times larger than India ($133), its PQLI is no higher.

It is clear that, as a by-product of growth in income, PQLI progress comes slowly. The rich oil states have not had their high incomes for long. However, their low PQLI results do not necessarily reflect a lack of effort. In many of these countries, considerable revenue is devoted to social services. But even the force-feeding of social overhead improvements does not yield immediate results. Along with larger per capita incomes and social will, there is also need for time--time to design appropriate institutional systems and to integrate appropriate social and individual behaviors.

TABLE 5

Five High-Income Countries with Low PQLIs, early 1970s

| | Per Capita GNP ($) | PQLI |
|---|---|---|
| All High-Income Countries (average) | 4,404 | 92 |
| Kuwait | 13,787 | 74 |
| Libya | 4,402 | 45 |
| Qatar | 11,779 | 31 |
| Saudi Arabia | 3,529 | 29 |
| United Arab Emirates | 14,368 | 34 |
| All Low-Income Countries (average) | 155 | 40 |

At the other end of the spectrum, six countries with per capita incomes still under $700 have already achieved a PQLI of 77 (Table 6). Eight additional countries with per capita incomes below $700 have ratings of 68 or more. Table 6 shows that the results measured by the PQLI do not flow from development choices that are made only by a particular type of economic-political system. Cuba, the Republic of Korea, Sri Lanka, and (before their rapid rises in per capita GNP) Costa Rica, Hong Kong, and Taiwan--with very different political systems--all achieved PQLIs in the mid-80s at per capita GNP levels below $700. Other countries with equally varied systems--China, the Philippines, Colombia, and others--have been able to attain PQLI levels that are only slightly less satisfactory. Sri Lanka and the Indian state of Kerala, where extremely low per capita GNPs are associated with quite high PQLI ratings, are the most striking examples.

At the moment, understanding of how and why these favorable aberrations have come about is limited. Some countries, whether by design or by force of circumstances, have employed policies that have been unusual in their effects. The particular strategies that have produced these results may offer insights on how to improve life chances more rapidly than has been possible with orthodox development policies. For example, if the PQLI of countries having per capita GNPs of $700 or more and PQLIs below 68 could be raised to 68, over 143 million people would be affected. If countries having per capita

## TABLE 6

### Low- and Lower- Middle-Income Countries with High PQLIs.

| | Per Capita GNP ($) | PQLI |
|---|---|---|
| All Low-Income Countries (average) | 155 | 40 |
| Sri Lanka | 179 | 82 |
| Kerala State, India[1] | 126 | 68 |
| All Lower-Middle-Income Countries (average) | 340 | 67 |
| **PQLI of 77 or over** | | |
| Cuba | 640 | 84 |
| Grenada | 465 | 77 |
| Guyana | 559 | 85 |
| Korea, Republic of | 464 | 82 |
| Western Samoa | 300 | 84 |
| **PQLI of 68-75** | | |
| Albania | 530 | 75 |
| China, People's Rep. | 300 | 69 |
| Colombia | 526 | 71 |
| Ecuador | 505 | 68 |
| Mauritius | 552 | 71 |
| Paraguay | 533 | 75 |
| Philippines | 342 | 71 |
| Thailand | 318 | 68 |

NOTE: Three additional countries--Costa Rica, Hong Kong, and Taiwan --presently with incomes higher than $700 achieved POLIs of 77 or more in the early 1960s, when their per capita incomes were still below $700.

[1] While the Indian state of Kerala is not an independent country, it is included not only because fairly good data are available, but also because of its anomolously high PQLI (in comparison with the all-India average of 43) and low per capita income (India's per capita income is $133). Moreover, its population of 21 million makes it larger than many countries. Kerala's PQLI is based on an infant mortality rate of 58 deaths per thousand live births, a life expectancy at age one of 66.4 years and a literacy rate of 60 percent (corresponding Indian figures are 122, 56 and 34).

incomes of more than $179 could duplicate Sri Lanka's experience, 1.6 billion people would be affected.

Country clusters. Countries are not randomly scattered; there tends to be some clustering of PQLI values. Of the forty-three countries with the lowest PQLIs of 36 or less, all but ten are African. Of these ten, five--the Yemen Arab Republic, the People's Republic of Yemen, Saudi Arabia, Qatar, and the United Arab Emirates--are Arab; three--Afghanistan, Nepal, and Bangladesh--are South Asian; the other two countries are Haiti and Laos. On average, the African countries individually and collectively tend to rank substantially higher on a per capita GNP scale than on a PQLI scale.

Although emphasis is often put on Latin America's poverty and its gross maldistribution of income, it has clearly reached a higher level of PQLI performance than the African countries. Latin American countries generally also perform substantially better than South and Southeast Asian countries. With the exception of Haiti (with a PQLI of 36), Bolivia (43), and Honduras (51), no Latin American country has a PQLI as low as the highest state in Africa (South Africa, 53). While no Latin American country has reached a PQLI of 90 equivalent to the European values, the Latin American average of 71 is comparable to the East Asian average of 73. The world average PQLI weighted by national populations is 65.

South Asia, with a PQLI average of 41, seems to have its own pattern which, even though Afghanistan (18) and Nepal (25) are included, still is well above the African average of 32. On the other hand, it is below the average for Southeast Asia (55). When disaggregated, Southeast Asia seems to have three groupings: Kampuchea and Laos, with very low PQLIs; Indonesia, Vietnam, and Burma, with PQLIs close to the regional average; and Malaysia, Thailand, the Philippines, and Singapore, with PQLIs well above the average. There are other visible clusterings; one of these is found in the Caribbean; with the exception of Haiti (36) and the Dominican Republic (64), the other Caribbean islands all have PQLIs in or near the 80s.

Development discussions often imply that all poverty is of much the same sort and can be confronted in much the same way. Differences in the nature and scope of poverty often are attributed to resource differences, technical differences, and narrowly defined economic differences. They may to some extent be defined by continent--there are African, Asian, and Latin American poverty problems. But physical geography is not the decisive element. The clustering seems to express similar forms of social organization and historical experience that are relevant to a nation's capacity to deliver inputs which contribute to PQLI results. Detailed explanations are not possible without much more research and analysis; but it does seem apparent that the problems confronting black African states as a group (and probably also Afghanistan, some of the Arab states, and others) in trying to raise their PQLIs are probably quite different from those that confront South Asian, Southeast Asian, or North African countries as a group, or Latin American countries as another group. Thus specific attention should be paid to these institutional differences and to their policy implications.

Distribution of benefits. The PQLI's components express distributional characteristics. Changes in literacy, infant mortality, and life expectancy at age one reflect changes in the availability of these benefits to the whole population. Overall the PQLI is a much simpler measure of benefit distribution than those that try to measure the distribution of national incomes.

The World Bank has compiled income distribution figures for sixty-six countries, measuring inequality by the share of income going to the poorest 40 percent of households. The smaller the share going to this group, the more unequal income distribution was said to be. The Bank's income distribution measure and the PQLI do not appear to correlate well. There seems to be no correlation between income equality and PQLI. The PQLI captures the total effect of social and economic policy as well as results of the way private income is spent. These welfare results cannot be predicted from income distribution data any better than from average income levels.

## Special Purpose PQLIs

Because literacy, infant mortality, and life expectancy data presently are not available by income classes within countries, it is not possible to construct a PQLI to compare them. PQLIs can, however, be constructed for other intra-country categories that, in turn, can yield significant information about the distribution process. PQLIs describing differences among ethnic groups (where they are tabulated by data collectors), among sub-national geographical regions, between females and males, and between rural and urban sectors can be constructed.

Male and female PQLIs. Of the seventy-three countries for which data--of varying quality--are available on sex differences, there are twenty-eight in which the female PQLI was lower than the male PQLI in one or more years between 1949 and 1972; eighteen had differences of more than three points ranging from 4 to 11. The list includes countries at various levels of income and PQLI; they do not seem to be concentrated in any culture area.

Female literacy rates are lower in sixty-six of the seventy-three countries. The most extreme case is Burma with a difference of 49 points in 1955. On the other hand, female performance in infant mortality and life expectancy at age one is typically better than male performance. India (1970) is the only country for which all three indicators registered worse performance for women than for men. The evidence suggests that, both where infant mortality rates are very high and where they are extremely low, females generally have higher survival rates. Similarly, women seem to have longer average life spans and, as average life expectancy rises, the gap between females and males seems to widen. In countries with the longest average life expectancies, there currently is a difference of six to eight years between the life expectancies of men and those of women. For the purpose of making most development policy, such differences may not matter, since the basic task if to raise the average PQLI for both sexes. But where policy is focused on the condition of women, it may be desirable to develop separate PQLIs.

Rural and Urban PQLIs. Rural-urban comparisons are more difficult to make. Generating such data is a task that has long frustrated demographers. Thus far rural-urban PQLI data are available for only three developing countries (see Table 7).

TABLE 7

Rural and Urban PQLIs for Three Countries, early 1970s

| | Rural | Urban | % Urban Superiority |
|---|---|---|---|
| Ghana | 28 | 54 | 93 |
| Indonesia | 45 | 61 | 36 |
| Liberia | 27 | 42 | 56 |

The gross superiority of urban PQLIs shown in the three developing countries is somewhat surprising. Development literature and policies have stressed the great influx of people into urban areas and the consequent strains on previously inadequate social infrastructure. The high population densities, the gross poverty of large groups of people, and inadequate public facilities would lead one to expect worse conditions in the city than in the countryside. These limited data suggest that--in spite of fairly widespread ideas about the horrors of urban existence in less developed countries--the developing-country towns seem to offer people better physical life chances of the kind measured by the PQLI than exist in the countryside.

## Conclusions

The Physical Quality of Life Index promises to serve as a creative complement to the GNP. By focusing on results rather than inputs, it records how widely certain basic characteristics are distributed within and among populations. It informs about the changing distribution of social benefits among countries and, within a country, between the sexes, among ethnic groups, and by region and sector. By minimizing the developmental and cultural ethnocentricities that bedevil most other measures, the PQLI facilitates international and regional comparisons. Because it is bounded at the upper end, the PQLI can be used to set objectives that are achieveable. As countries move slowly or less slowly toward closing the gap between their current performance and that presently considered to be the maximum attainable performance, the gap between "rich" and "poor" countries can be expected to narrow.

The PQLI disparities among countries can be understood in a way that disparities in per capita GNP sometimes are not. Knowing that, in absolute terms, world poverty is so extreme that in 1969 about half the combined populations of Latin America, Africa, and Asia (excluding China) lived with average per capita incomes below $75 (in 1971 prices) is not very meaningful, especially when, in most of these countries, life expectancies are increasing and infant mortality rates are declining at the same time. The numbers obviously do not mean that these people are living for a year on what a person in the United States could buy with $75. Yet if they are used merely to note that there are a great many poor in the world, they may in fact do more harm than good. Such well-intentioned but shrill and unqualified presentations tend to discourage, rather than to elicit, remedial action.

The PQLI, in contrast, does not create the picture of a hopeless race. In fact, it avoids the necessity of thinking about national development as a race at all. It places a country on a meaningful scale in relation to specific and fixed objectives, and records over time its performance toward meeting those objectives.

[Extracted from Measuring the
Condition of the World's Poor,
The Physical Quality of Life Index,
Chapters 1, 4, 5, 6. Published by
the Pergamon Press Ltd., Oxford,
England, for the Overseas Develop-
ment Council, Washington, D.C.
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# The Social Accounting Matrix

**Graham Pyatt and Erik Thorbecke**

[In order to plan policies in which the objectives of growth and equity for the poor are considered, and to estimate what the results of various policy combinations will be, an integrated framework is needed. This article describes how a framework for this and related purposes can be constructed, and the required data identified.]

A major research project is underway on planning for growth, redistribution and employment, in an attempt to understand how the interaction of different forces within a developing economy determines its progress. The main emphasis is on the links between growth, inequality and employment, and not least on how the extent of poverty and changes in it are related to familiar issues of savings and investment, balance of payments, production and distribution. The approach to these questions is basically that of the economic planner. In this survey of the main research project we present some of the major elements of the proposed framework to show its operational usefulness in policy formulation. While the work is mainly technical, its context is one of practical and urgent development problems, and the need to identify policies capable of resolving these problems. A comprehensive planning framework and data system are built in order that the way in which the living standards of different groups within society are determined and the roles they play in the process of economic development may be perceived. From this we try to obtain a better appreciation of those forces which create a dynamic for growth, and those which leave behind, in poverty, substantial fractions of the population.

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We begin by stating that what interests us most is the living standards of different groups within a society. An initial problem, therefore, has been to examine the possibility of measuring living standards and to set these measures in a comprehensive empirical framework and data system which shows numerically what is going on in any economy, and how the living standards of different groups are related both to each other and to other aspects of economic activity. The United Nations System of National Accounts does not do this. One of our main recommendations is that work on national data systems can and should be reorganized so that planning can be concerned with poverty and inequality as well as with growth. An important part of our work is concerned with suggesting appropriate classification schemes, and placing the relevant facts on a consistent basis to measure and analyze jointly the determinants of growth, income distribution and employment. Clearly, the prevailing informational systems used by policy makers could be greatly improved in this respect.

Data systems do not exist independently of a conceptual framework. The reason why national income statistics do not contain an integrated statement of living standards for different groups is that distributional questions are not part of the conceptual framework which underlies them. That framework is preoccupied with growth: therefore, separate statistics on income distribution imply a conceptual framework which regards inequality as a separate issue, and a more equal distribution of income as a policy objective in its own right. Our concern to bring the two sets of data together in an integrated whole reflects the fact that their inter-relationship is essential. The crux of the problems facing many developing countries concerns the potential conflicts between policies to encourage growth and those which will do something in the short term to ameliorate the lot of the poorest members of society. If these conflicts are to be understood we need a conceptual framework which embraces them simultaneously and focuses on the links between them, both actual and potential. A general data framework is then needed to serve the conceptual framework, and not as an end in itself.

A conceptual framework which brings together growth and inequality in a comprehensive way is the main theme of this research. The framework itself is modular, consisting of a set of inter-related subsystems. [A module is an interchangeable unit that can be used in construction of a building in which a number of different modules function together.] Since it incorporates a large set of policy measures, the alternative effects of different development strategies --i.e. different packages of policy measures--on growth, equity and employment can be analyzed quantitatively.

Our comprehensive planning framework is built upon two pillars: (a) a modular analytical framework specifying, for a set of interconnected subsystems, the major relationships between variables within and between these subsystems; and (b) an elaborate complementary data and classification system. These two pillars can be combined together into a social accounting matrix (SAM), containing not only the comprehensive data system for any given period but the whole algebraic specification of the dynamic model linking the various variables and subsystems and permitting the derivation of future equilibrium values and, consequently, future SAMs.

As a data framework, the social accounting matrix is a snapshot at one particular moment. It provides a classification scheme for data which is useful in the light of policy needs and available to the planners. The SAM framework also incorporates explicitly various crucial transformations between variables, such as the mapping of factorial income distribution from the structure of production, and the mapping of the household income distribution from the factorial income distribution.

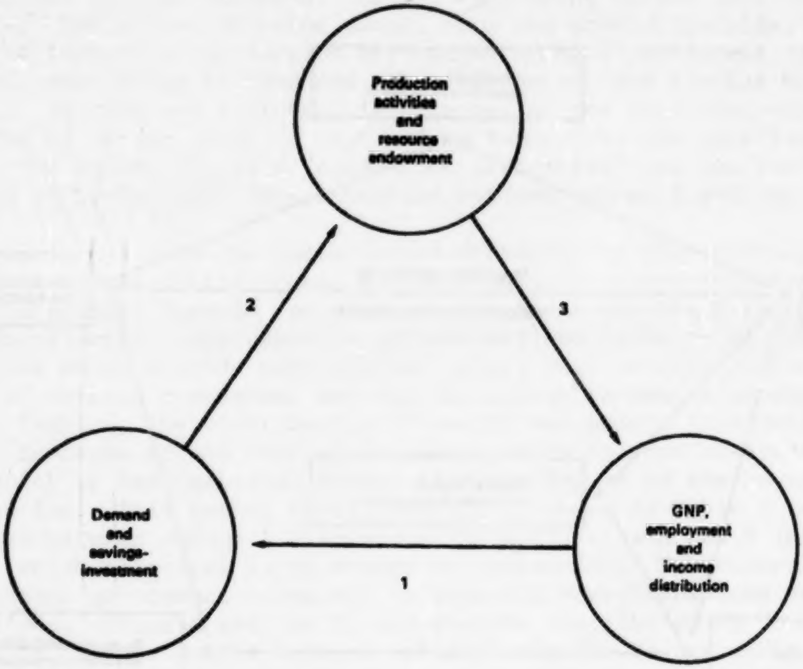
## The Conceptual Planning Framework

Perhaps the simplest starting point in describing our framework as an analytical system is to recall the inter-relationship between (a) the structure of production; (b) the distribution of the value added generated by the production activities; and (c) consumption, savings and investment. Figure 1 reflects this interrelationship in terms of the three links. Such a system should be internally consistent, in both a static and a dynamic sense. The static requirements are that, starting at any point in the triangle, the feedback mechanism throughout the system should yield the same initial set of values. For instance, if the starting point is a given pattern of income distribution and employment, corresponding expenditure and investment effects are implied by link 1 in the diagram. In turn, this implies a given output mix through link 2, which then translates via link 3 into a derived demand for factors, and corresponding household income distribution equivalent to the one which was initially selected. The last distribution must be the same as the distribution assumed initially.

The logic underlying our modular planning framework and its corresponding data system is more complex than the triangular scheme presented in Figure 1. The major module of that framework, as well as the causal interdependence between the former, is given in Figure 2. This diagram is a simplified subset of the complete system which is shown below in Figure 3 and discussed in detail. (Figure 2 emphasizes those parts and relationships of Figure 3 which are drawn in double lines in the latter.)

FIGURE 1

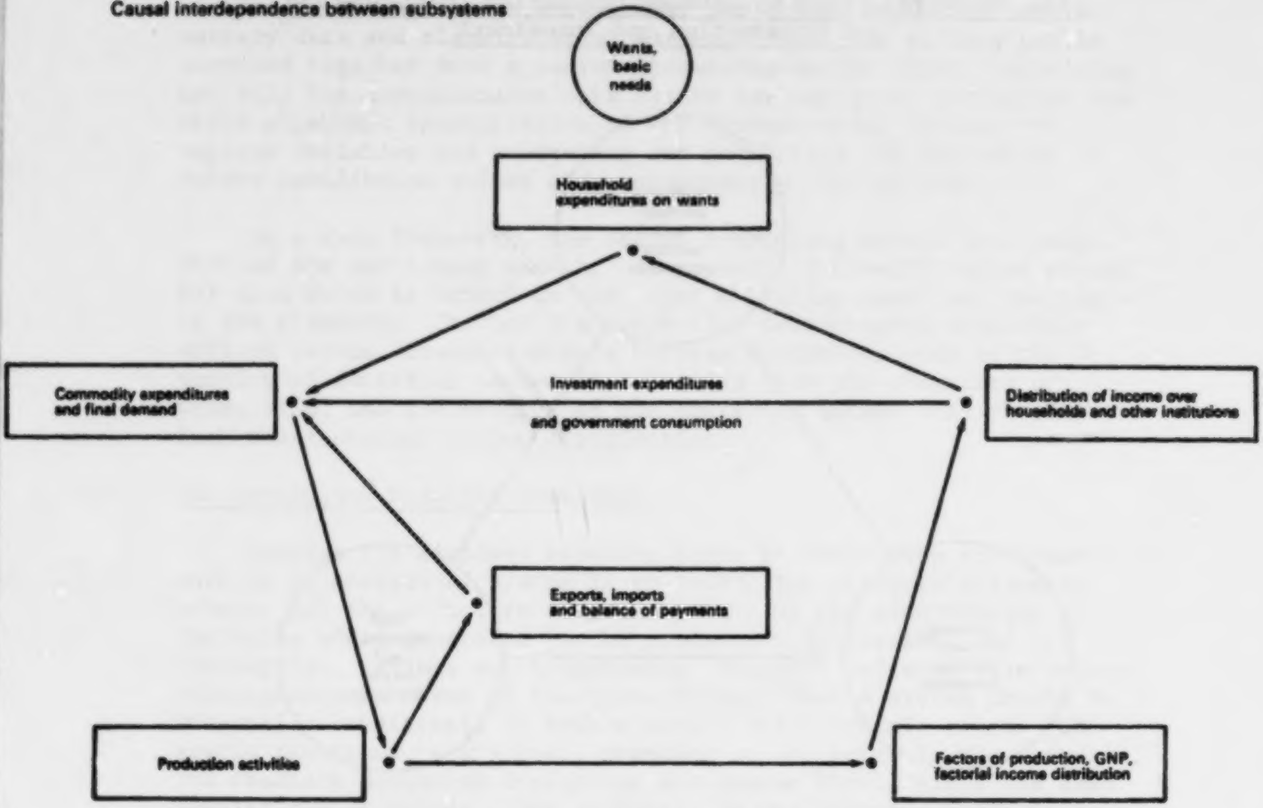
The Inter-relationship between Production, Distribution and Consumption and Investment


Production activities and resource endowment
2
3
Demand and savings-investment
GNP, employment and income distribution
1

Since our conception of economic and social development is the attainment of higher standards of living for all, but particularly for the poor members of society, the logical starting point is a recognition that households have basic needs and wants which can be satisfied through the purchase of a bundle of commodities. In turn, the total effective demand for the set of commodities desired is met by the output of the whole constellation of production activities. The next loop in the circular flow in Figure 2 consists of the derived demand for the factors of production generated by the production activities which yield the factorial income (value added) distribution and GNP. Finally, the factorial income distribution can be mapped into a distribution of income over households and other institutions (i.e. government and companies) which completes the interdependent system by providing the means of satisfying household and government wants, as well as investment requirements, thus bringing us back to our initial point.

FIGURE 2

Causal interdependence between subsystems


Wants, basic needs
Household expenditures on wants
Commodity expenditures and final demand
Investment expenditures
and government consumption
Distribution of income over households and other institutions
Exports, imports and balance of payments
Production activities
Factors of production, GNP, factorial income distribution

Conceptually, it is through the production process that value added accruing to the various factors of production is generated. In turn, value added received by the factors, complemented by and corrected for transfer payments, taxes and subsidies, has to be mapped into a corresponding household income distribution. Thus, three levels or steps can be distinguished in this mapping process: (a)the structure of production, typically broken down into a number of production sectors or activities; (b) the factorial distribution of value added; and (c) the household distribution of income. In the process of mapping the household income distribution from the streams of value added generated by the production activities, a crucial question is that of an appropriate classification scheme for the various accounts in the SAM. If the transformation from the structure of production to the factorial, and ultimately the household, income distribution is to be performed in an operationally useful way for planning purposes, great care must be exercised in designing appropriate classification schemes for each account.

Thus our data system incorporates--what national income accounts ignore--the mechanisms that translate the generation of value added by production into the income of different types of households and other institutions. The link is provided by factors of production. The level and structure of output by the different activities generate the aggregate demand for labor of different types, natural resources, and capital services. Hence, employment enters into the analysis. The stream of value added, from the production side, rewards the factors of production with wages going to different types of labor, rent going to land and other resources, and profits to capital. In this way a picture is obtained of the factorial distribution of income which is captured in Table 1 by the interface between the column entitled "production activities" and the row "factors of production" (the interface between column 6 and row 1).

Translation from the factorial distribution to the distribution of incomes across institutions, and particularly across different household groups, depends on which institutions own which factors. Thus, for example, wage payments to semi-skilled labor go to the households which provide semi-skilled labor; rent accrues to the owners of natural resources; and profits accrue to owners of capital. In this fashion, the distribution of wealth and assets (including skills) in terms of who owns or possesses which factors underlies the mapping of the factorial income distribution on to the household distribution. This second transformation is shown in Table 1 in the interface between column 1 (factors of production) and row 2 (households), which allocates labor income to households. Furthermore, when current government transfers to domestic households (the interface between column 4 and row 2) and profits distributed to domestic households (the interface between column 3 and row 2) are added to the labor income of the households, the complete household income distribution is obtained. It follows that the latter can be changed either (a) by altering the factorial distribution; (b) by changing the distribution of wealth in terms of factor ownership; or (c) through a different pattern of transfer payments.

There are two further considerations which our accounting framework must embrace. First, the existence of wealth implies accumulation, and hence savings to finance it. Savings also provide a difference between income and consumption for different groups in the population. It is important, therefore, to include capital accounts in our framework, to note the amount of savings available to finance investment--who saves, and who invests. At the same time we want to dissect the commodity composition of consumption so that living standard comparisons can be made. Finally, our accounts must cover relations with the rest of the world in terms of merchandise trade, international factor and non-factor payments, international capital movements and foreign aid.

## TABLE 1

A basic social accounting matrix (SAM)

| | | | | | Expenditures | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| | | | | | | Institutions | | | | | | |
| | | | | | Factors of production | Current accounts | | | Combined capital account | Production activities | Rest of the world combined account | Totals |
| | | | | | | Households | Companies | Government | | | | |
| Receipts | | | 1 | Factors of production | | | | | | Value added payments to factors | Net factor income received from abroad | Incomes of the domestic factors of production |
| | Institutions | Current accounts | 2 | Households | Allocation of labour income to households | Current transfers between households | Profits distributed to domestic households | Current transfers to domestic households | | | Net non-factor incomes received from abroad | Incomes of the domestic institutions after transfers |
| | | | 3 | Companies | Allocation of operating surplus to companies | | | Current transfers to domestic companies | | | | |
| | | | 4 | Government | | Direct taxes on income and indirect taxes on current expenditure | Direct taxes on companies plus operating surplus of state enterprise | | Indirect taxes on capital goods | Indirect taxes on inputs | Net non-factor incomes received plus indirect taxes on exports | |
| | | | 5 | Combined capital account | | Household savings | Undistributed profits after tax | Government current account surplus | | | Net capital received from abroad | Aggregate savings |
| | | | 6 | Production activities | | Household consumption expenditure on domestic goods | | Government current expenditure | Investment expenditure on domestic goods | Raw material purchases of domestic goods | Exports | Aggregate demand = gross outputs |
| | | | 7 | Rest of the world combined account | | Household consumption expenditure on imported goods | | | Imports of capital goods | Imports of raw materials | | Imports |
| | | | | Totals | Incomes of the domestic factors of production | Total outlay of households | Total outlay of companies | Total outlay of government | Aggregate investment | Total costs | Total foreign exchange receipts | |

Table 2 shows in a more consolidated form than the previous table the mapping from the structure of production to the distribution of income. (Table 4 below represents an application of the format of Table 2 to the data from Sri Lanka.) Table 2 is built around a central aggregate, the total income of the domestic factors of production. In the northeast quadrant (i.e. the upper right portion of the diagram) we have the details of how this depends on the structure of production and factor markets. In the northwest quadrant this total income is allocated to the institutions, and particularly the households, which provide the factor services. Hence, the distribution of wealth--defined to include human skills as well as capital--underlies this northwest quadrant. In the southwest quadrant the effects of transfer payments, i.e. of profit distribution, taxation and government social security payments, are shown. As a result of these last transactions, the central aggregate is decomposed into the disposable income of the institutions including the households.

Tables 2 and 4 are useful in revealing the determinants of the income distribution. A first determinant is the structure of production and factor markets, including labor markets. Next there is the distribution of wealth, defined to include human skills; and finally the fiscal system of taxation and benefits. All three are basic elements, and any policy to influence the distribution of income needs to focus on all three of these areas.

## TABLE 2

### Tableau for the Analysis of Income Distribution

| | | Institutions current accounts | | | Total | Production activities | Rest of the world |
|---|---|---|---|---|---|---|---|
| | | Households | Companies | Government | | | |
| Factors of production | Labour | Allocation of labour income to households | | | Factorial distribution of income | Wages | Net factor incomes received from abroad |
| | Other | Allocation of surplus of unincorporated enterprises | Allocation of operating surpluses to companies | | | Operating surpluses | |
| Totals | | Distribution of factorial income over institutions before transfers | | | | Value added | Net factor incomes received from abroad |
| Institutions current accounts | Households | Distribution of factorial incomes over institutions minus total transfer payments | Profits distributed to domestic households | Actual and imputed current transfers to households | Distribution of disposable income | | |
| | Companies | | | Current transfers to domestic companies | | | |
| | Government | Direct taxes on income | Direct taxes on companies plus operating surpluses of state enterprises | | | | |
| Rest of the world | | Net non-factor incomes paid abroad | | | Net non-factor incomes paid abroad | | |

* = Aggregate income of the domestic factors of production.

It is important to remember, however, that in reality the structure of production and income distribution are inter-related through the interdependent system represented in Figure 1. It is this causal interdependence which accounts for the substantial element of simultaneity that exists in the determination of the output and incomes. It is therefore not easy to change income distribution, since its determinants are to a considerable extent woven into the structure of an economy and cannot easily be disentangled. This is a recurring theme in the analysis and an important point of emphasis for perception of the issues.

## Towards an Integration of the Conceptual Planning Framework and the Data System

At this stage it is important to integrate more formally the conceptual framework and the data system we have just discussed into a comprehensive social accounting matrix. Figure 3 sets out the comprehensive conceptual economic framework, and serves as an organizing scheme for subsequent analysis. It is, as noted above, an extension of Figure 2. The arrows linking different parts of the system reflect causal connections. The relationships are discussed individually, or grouped into subsystems in our main research, and are to be considered as modules in a more complete system. This modular approach has certain advantages: it implies that the complex of interactions in Figure 3 can be discussed separately, module by module.

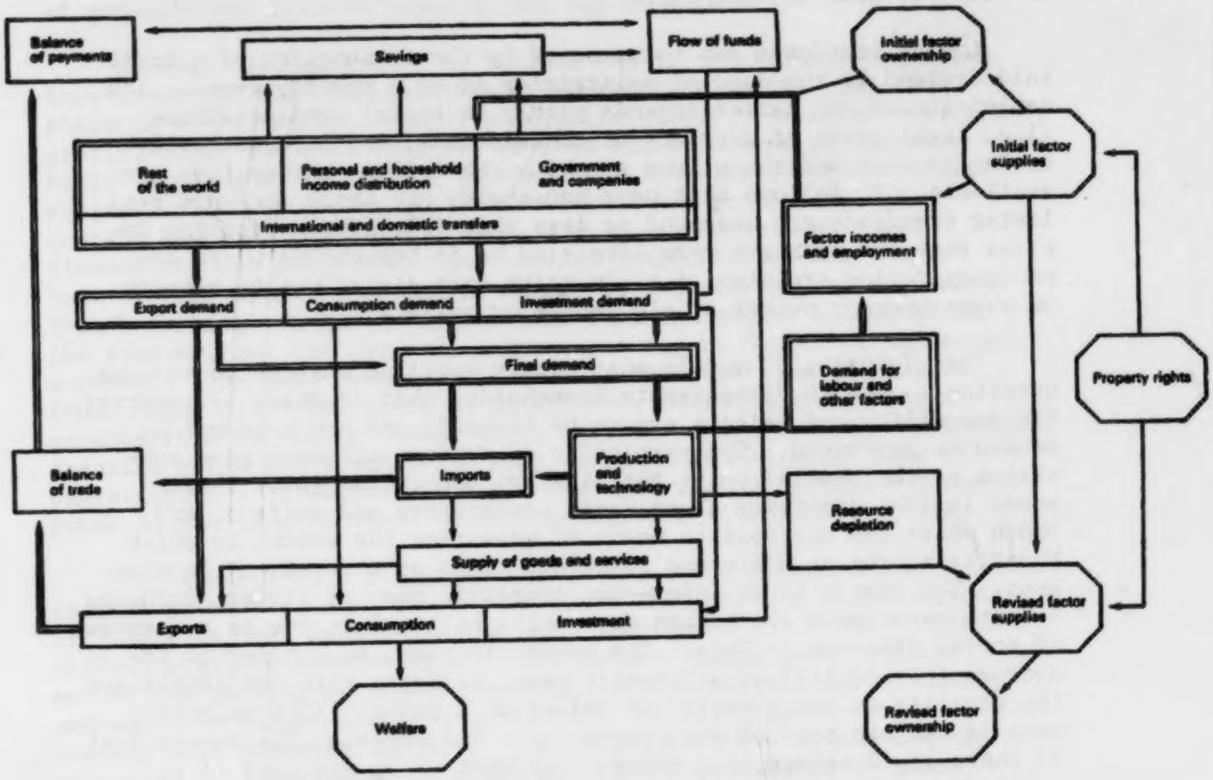
The major modules presented below are: (a) households and living standards; (b) savings, investment and the flow of funds subsystems; (c) final demand and its link with production; and (d) the structure of production and asset ownership and its relationship to income distribution and employment. It should be noted that Figure 3 depicts an interactive system of mostly simultaneous relationships. Given our concern for the living standards of different socioeconomic groups, we begin with module (a).

Households and their living standards. Conventional treatments which subdivide households by income level are not very helpful for a number of reasons. Policies have to be directed to particular groups which are identifiable directly in policy terms, and this usually means production categories. Examples are semi-skilled industrial workers, landless rural labor, workers in the informal urban sector, and rentiers. Policies can be formulated according to their impact on such groups. By contrast, individuals who earn between a quarter and a half of the average level of income are hard to legislate for as such. It follows that an operational approach must be based on a socioeconomic classification distinguishing identifiable (and relatively homogeneous) groups which can be reached by policy means. In its simplest form such a classification could be analogous to that distinguishing between urban, rural and estate households in Sri Lanka (see Table 4). In general, however, it is desirable to specify a more thorough and disaggregated classification.

In our approach we suggest that there are three main criteria on which a household classification should be based: (a) location; (b) sociological considerations; and (c) wealth. Location is justified on the grounds that policy often has a locational element and that the regional fragmentation of job opportunities, for example,

FIGURE 3

The Modular Conceptual Framework


Balance of payments
Savings
Flow of funds
Initial factor ownership
Initial factor supplies
Rest of the world
Personal and household income distribution
Government and companies
International and domestic transfers
Factor incomes and employment
Export demand
Consumption demand
Investment demand
Final demand
Demand for labour and other factors
Property rights
Balance of trade
Imports
Production and technology
Resource depletion
Supply of goods and services
Exports
Consumption
Investment
Revised factor supplies
Welfare
Revised factor ownership

can be important. The sociological factors which may be relevant are race, religion and language. These may be the basis of market fragmentations or other forms of discrimination. Ethnic groups comprise a significant fraction of the poor, especially in Latin America. Otherwise such factors matter because of differences in consumption habits, for example, or participation in different lines of production. Wealth is important at several levels. Access to land is a critical consideration in rural areas, and the landless can be affected quite differently from the smallholder by development policies. The truly rich are similarly quite distinct, and their role in the process of savings and investment calls for special consideration. They stand to lose by redistributive policies which are not underpinned by significant growth. Their behavior and incentives are therefore potentially critical.

Having defined classification criteria for household groups, we argue that the main concern should be with the average level of living standards in each group. This averaging implies that variations within groups do not receive much attention, even though an average may conceal a considerable range of variation. However, there is a limit to the amount of detail that can be sustained, and we draw the line at this point.

Living standards can be measured by the consumption of a household divided by the cost of maintaining it at a poverty level. The definition of the latter depends partly on social considerations (i.e. local views of adequacy of consumption), and more generally on family size and the prices at which the defined necessities are available. It follows that poor households are those for whom real living standards are measured as less than 1.0. The definition implies that the poor are more likely to be in households where dependency ratios are high, i.e. in which each earner has to support an above-average number of old people or children.

This "household" module must supply specific answers to various questions: how to disaggregate households; what is meant by poverty; how inequality and welfare are to be treated; and how consumption demand is generated. The particular mechanisms proposed give substance to the general point that the way households spend their money implies something about their preferences and welfare, and hence about the appropriate means of measuring the extent to which benefits accrue to different household types as a result of development. The result is an index--the geometric mean of living standards --which makes more sense than per capita national income as a measure of social progress. [Note: The geometric mean, as opposed to the average (per capita) or arithmetic mean, reflects both the levels and the equality in distribution of values in a group. (The geometric mean is the nth root of the product of n values--e.g. the square root if there are 2 values in a group, cube root if 3, 4th root if 4, etc.) In a simple example: two villages have 2 people and the same average income. In village A incomes are 9 and 2, in B they are 5 and 6; $11 \div 2 = 5.5$. But in A $9 \times 2 = 18$ and $\sqrt{18} = 4.24$; in B $5 \times 6 = 30$ and $\sqrt{30} = 5.48$.]

Savings, investment and the flow of funds. Considerations regarding the relationship between savings and investment are important for our analysis. We are doubtful about the evidence which suggests that greater equality reduces personal savings. But such changes in income distribution will alter the pattern of who saves, and hence who invests at the household level. Similarly, any change in profit levels will most probably alter the investment of private companies. In these respects, therefore, inequality and economic growth are intimately connected. Profits must be available to finance investment if private domestic companies are to play a leading role in growth. But there are alternatives, among them private investment from overseas (which brings in expertise also), and foreign aid to finance public investment. Both operate through international capital transactions and in part explain the link between balance of payments and flow of funds at the top of Figure 3.

Another alternative is to finance public investment, including investment in state corporations, from domestic funds. But here there is a difficulty. Public enterprise rarely runs at an over-all profit, often for good reasons. Prices are held down to provide basic services at subsidized levels, thus reducing poverty. Externalities might be generated so that efficiency prices are below costs. Whatever the cause, the fact that government can rarely finance its own investment from current surpluses implies that it must borrow, with the potential danger of inflationary consequences. This borrowing, in turn, implies less real investment elsewhere in the economy, and the over-all achievement may be better or worse as a result. The main concern is that different patterns of flow of funds imply different sorts of investment, that the institutional arrangements in capital markets can preclude some patterns of credit creation which would otherwise help to build up the asset base of poorer members of society. Thus investment demand in Figure 3 depends on the flow of funds as well as being a determinant of it.

The central role played by assets and their distribution emerges at this point. The link between them and the distribution of factor incomes appears in the northwest corner of Table 2 (specifically as the allocation of labor income to different skills, and of the surplus of incorporated and unincorporated enterprises), and again in Figure 3 as the arrow from "initial factor ownership" leading into domestic incomes. Increments to these assets are represented by investment, in which we include investment in human skills through training and education, as well as factories, offices and roads. If, therefore, income distribution is to be changed through encouraging asset accumulation by the poorest at above-average rates, either the poorest must be provided with credit or they must be able to finance investment from their own savings. If the latter were possible it is unlikely they would be so poor. The former may require new institutions and a diversion of resources from other investment opportunities. Power politics may preclude this. If not, the question remains whether investments which provide assets for the poor will generate as many social benefits as could be derived from other investment opportunities which have to be forgone. It is this potential conflict which can lead to tradeoffs between growth and reduced inequality. Equally, some strategies may be conducive to both.

Final demand and its link with production. Consumption, investment and export demands make up the final demands on production activities and hence determine levels of output and imports. Most development planning models make strong assumptions regarding the above relationship. Our concern has been to set out a more flexible treatment which allows the link between final demand and output to be handled with greater sensitivity.

The first point to make is that prices are determined endogenously within the general framework, rather than being specified separately in advance. For some goods demand is very insensitive to price (price-inelastic) - for example, recent rises in oil prices and in prices of manufactured goods did not result in dramatic falls in quantities imported but in large balance of trade deficits. For other goods demand is highly elastic, so that relatively small changes in price will radically alter the quantities purchased. By allowing imports to be sensitive to prices in varying degrees, our approach makes it possible to explore how tariffs and quotas influence the economy, and to ascertain the optimal exchange rate policy to adopt. This may seem a long way from questions of poverty and inequality; but if production is restricted for lack of spare parts or raw materials, employment must drop. Lack of foreign exchange may mean food shortages when countries are not self-sufficient, and the general restriction on both production and incomes which follows from a balance of payments constraint may be the reason why output has to be sacrificed to obtain more jobs.

The extent to which an economy relies on imports depends on the structure of demand relative to production, i.e. on how much import substitution has already taken place and the scope for further developments along these lines. The latter depends in turn on the resource base of the economy and, more generally, on its comparative advantage in trade with others. To answer such questions it is essential to know how prices are determined within the economy.

Since prices are determined within our analytical framework, the design of fiscal policy can be explored. Such policy instruments as direct and indirect taxes, export subsidies and public utility pricing policy all improve or impair the performance of the economy relative to its objectives. We have not undertaken a specific country study to evaluate these issues, but it seems that at some point the poorest of the poor can be helped only by fiscal transfers. The relevant questions then would be how transfer policies should be designed for maximum effect, and what their costs are in other respects.

Another aspect of our treatment of the way in which demand translates into production is that it reveals where capacity is short. This is important for recognizing the investment opportunities in an economy--the lines of activity which might be expanded and the new activities which might be started. Alternative plans can consequently be evaluated on the basis of shortages in current production capacities.

The structure of production and resource ownership and their relationship with income distribution and employment. The analysis has now covered all but the links on the right-hand side of Figure 3. The detailed discussion has built up from the distribution of income to the structure of production, and included both balance of payments and flow of funds considerations. This involves some extensions of traditional methods. The outstanding issues are less often discussed in a planning context. They include employment and wealth.

The details of the approach to labor markets which we adopt are not presented here. Their outcome is a formulation which recognizes four important points. First, equilibrium in labor markets can be brought about through (a) adjustment of unemployment and underemployment rates in the typical case of excess supplies; (b) adjustments in output when, for example, key skills are scarce; and (c) adjustments in wage rates. The last of these three is an alternative to the first two. Our view is that in practice it plays a role only in the long term. Second, the formulation recognizes the importance of both education and experience in determining job opportunities and earnings. This corresponds to observed statistical relations which find these variables to be important. Third, a basis for migration is derived from the analysis which corresponds with the observed phenomenon whereby educated young males are found to be more successful than others in obtaining work subsequent to a move. And finally, the formulation yields ways of evaluating the prospective benefits to people from being better fed and better educated in terms of their expected earnings ability. Thus many of the important issues in labor market analysis are tackled, if not resolved.

Returning now to Figure 3, it can be seen that the interaction of demand for factors and available supplies generates the factorial income distribution and the pattern of employment, which represent major determinants of the distribution of household and personal income. This link corresponds to the northeast quadrant of Table 2, while the question of who owns the various factors underlies the northwest quadrant. Thus the modules are complete when we have specified the determinants of profits (or operating surplus) for each of the production activities--a question to which we now turn.

There is no easy answer to the question of what determines profits, and our approach allows for the interplay of various forces.

Our starting point is prices, since the question can be translated into the mark-up of costs which is used to determine selling price. At least three factors are important here. The first is the degree of competition. In traditional activities this is usually high, since there is freedom of entry and a potentially large number of producers. In modern sector activities there may be little competition because of state monopolies, markets limited in size, or protective barriers against foreign competition. A second important factor is the speed at which production activities operate. Experience in using new techniques usually leads to increasing efficiency over time. This implies that production lags are shorter, and hence that working capital can be reduced. Over time, therefore, the share of profits can be expected to fall for this reason. Finally, profit shares are likely to depend on the attitudes of entrepreneurs. If they require large expected returns to investment, increases in demand are more likely to spill over into imports than to elicit a domestic supply response in terms of increased capacity. Accordingly the share of profits depends on the responsiveness of entrepreneurs to investment opportunities. If they are reluctant to invest, increases in domestic demand result in higher prices, increased imports, or both. Conversely, an animated entrepreneurial class can translate increasing demand into economic growth.

Once investment is determined the system is complete, since investment minus resource depletion generates future factor endowments, which provide the initial conditions for subsequent period analysis. At this point, therefore, we need to consider how the various modules are formally integrated into the over-all framework.

## The Formal Incorporation of the Modular Framework into a Social Accounting Matrix (SAM)

The modules and their corresponding classification systems in Figure 3 can be translated into the social accounting matrix presented in Table 3. This table is an extension of the matrix presented in Table 1. The new elements, such as the detailed treatment of capital accounts to reflect the initial as well as the revised wealth held as factors of production (which were described in the modules of the preceding section), are incorporated into the new SAM. In fact, Table 3 is the informational counterpart of the modular system we have just discussed. Before we proceed, it should be recognized that empirical work today has not progressed very far beyond the quantification of the basic SAM shown in Table 1 and in Table 4 for Sri Lanka.

Table 3 involves 14 symmetrical rows and columns. (An additional fifteenth row is defined on a net basis and therefore does not spoil the over-all balance.) Since each row (and the corresponding

TABLE 3

## Final SAM Schema (Including Commodity Accounts)

| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Expenditures | | | | | | | | | | | | | | |
| | | | | | Current accounts | | | | | Capital accounts | | | | | | Current accounts | | | |
| | | | | | | | Domestic institutions | | | Domestic institutions | | | | | | | | | |
| | | | | | Wants | Factors of production | Households | Companies | Government | Households | Companies | Government | Domestic factor endowments | Financial claims | Rest of the world | Rest of the world net excl. imports | Production activities | Commodities | Totals |
| Receipts | Current accounts | | 1 | Wants | | | Want satisfactions | | | | | | | | | | | | Demand for want and need satisfactions |
| | | | 2 | Factors of production | | | | | | | | | | | | *Net factor incomes received from abroad* | Value added payments to factors | | Incomes of domestic factors of production |
| | | Domestic institutions | 3 | Households | | Allocation of labour income to households | | Profits distributed to domestic households | *Current actual and imputed transfers to h'holds* | | | | | | | *Net non-factor incomes received from abroad* | | | Incomes of the domestic institutions after transfers |
| | | | 4 | Companies | | Allocation of operating surpluses to companies | | | *Current transfers to domestic companies* | | | | | | | | | | |
| | | | 5 | Government | | | *Direct taxes rates* | *Company tax rates* | | | | | | | | | | | |
| | Capital accounts | Domestic institutions | 6 | Households | | | Household savings | | | | | | *Initial wealth held as factors of production* | *Initial wealth held as financial claims* | | | | | Revised wealth of the domestic institutions |
| | | | 7 | Companies | | | | Undistributed profits after tax | | | | | | | | | | | |
| | | | 8 | Government | | | | | Government current account surplus | | | | | | | | | | |
| Receipts | | | 9 | Domestic factor endowments | | | | | | Revised wealth held as factors of production | | | | | | | | | Revised factor endowments |
| | Capital a | | 10 | Financial claims | | | | | | Revised wealth as financial claims | | | | Flow of funds | Revised foreign claims on domestic institutions | | | | Revised financial claims |
| | | | 11 | Rest of the world | | | | | | | | | | *Initial foreign claims on domestic insts.* | | Balance of payments current account deficit | | | Revised foreign claims |
| | Current accounts | | 12 | Rest of the world imports | | | | | | | | | | | | | | Imports | Total imports |
| | | | 13 | Production activities | | | | | | | | | | | | | | Domestic supplies of commodities | Total revenue |
| | | | 14 | Commodities | H'sehold consump. demand for goods, services | | | | *Govt. demand for goods and services* | | | | Investment expenditure | | | Exports | Raw material purchases | | Total commodity demands |
| | | | 15 | Commodity taxes | | | | | Net commodity tax receipts | | | | | | | | | *Indirect tax rates, etc.* | |
| | | | | Totals | Supply of want and need satisfactions | Incomes of domestic factors of production | Total outlay of households | Total outlay of companies | Total outlay of government | Revised wealth as domestic institutions | | | Revised factor endowments | Revised financial claims | Revised foreign claims | Total for. exch. receipts *less* imports | Total costs | Total commodity supplies | |

column) is, in fact, a set of rows defined by the classification used with respect to that aspect of the economy, a very large table would be needed to show all the details. The SAM in Table 3 incorporates all the major transformations (such as that from the structure of production to the factorial income distribution, and from the latter to the household income distribution) and relationships contained in the modular framework. A change in any particular element, or account, occurring in this integrated and interconnected system must have repercussions elsewhere.

As in Table 1, the rows in Table 3 collect together receipts, while columns record the associated expenditures. Hence, each non-zero element of the table is a receipt when read in its row context, and an expenditure in its column. Row 1 of the table records wants in society. These are wants for food, clothing, housing, education, entertainment, leisure, etc. They are paid for by the expenditures of the different household groups in column 3. Thus at the intersection of row 1 and column 3 we have a table or submatrix showing how much is spent on each want (e.g. calories) by each type of household. The totals for the different wants in row 1 record the expenditures incurred in want satisfaction. For each household group these expenditures (or its consumption) are the numerator of its average living standard. The denominator is the poverty level, or the cost which would be incurred if all households in the group satisfied their minimum requirements but no more. Hence the matrix in row 1, column 3 records living standards and poverty within each socioeconomic group. Since we define the main policy objectives in terms of these variables, the purpose of the rest of the table is to ascertain how this particular submatrix is determined and may be altered.

It is quite evident from the above discussion that the quantification of the elements going into Table 3 is no trivial matter. However, it is worth noting that, subject to two main exceptions discussed below, the details it requires are already included within the United Nations System of National Accounts. Thus, subject to these exceptions, the details are within the system which countries have been recommended to adopt and which they have been making great efforts to introduce, and therefore the proposal to direct further efforts towards such a table is not in conflict with other recommendations and is not unrealistic. However, existing practice fails to capture the details which emerge from our study as being crucial. Evidence is difficult to produce, since to show the importance of classifications typically requires going back to primary data sources and reclassifying the results. While it is unfashionable to be concerned with economic statistics at this level, our analysis indicates that it is extremely important.

The two facets of economic activity introduced in Table 3 which are not part of the United Nations System of National Accounts are the accounts for wants, and the disaggregated household accounts. The households sector in aggregate is included, of course, while a disaggregated approach and much else that directly relates to our treatment of wants can be found in the United Nations' complementary System of Social and Demographic Statistics. But we do not want just a complementary system: the important point is to integrate questions of poverty and inequality into the aggregate economic framework--or even better to start off with them and to build the other details around them. One of our main recommendations is that work on national data systems can and should be reorganized so that planning can be concerned with poverty and inequality as well as growth.

## An Application of a Basic Social Accounting Matrix to Sri Lanka

Table 4 applies the basic format of the SAM shown in Tables 1 and 2 to the specific case of Sri Lanka.

Reading across row 1 of the table, urban labor earns wages equal to 1,673 (in millions of rupees). These come from all production activities, but the most important are trade and private transport services (414) and government services (555). These are also important sources of earned income for rural labor (row 2). For them, however, rice cultivation (706) is also highly significant. The estate labor force (row 3) earns income primarily on the tea plantations (526). Thus the table captures the relationship between the structure of production and the sources of wages and jobs in different labor markets. It also shows how private profits (4,984 in total) tend to be concentrated in "other agriculture" (vegetables, spices, fruits) and in trade and private transport services. The surpluses of state-owned enterprises add up to 174 net, there being some industries, such as trade and construction transport, in which state enterprise makes a loss. In general the top righthand corner of Table 4 shows how much factor income is generated in the economy, the production activities it is generated by, and the factorial income distribution, i.e. the extent to which each factor of production receives a share of this income. This is the main part of national income accounting by sector of origin and of the distribution of income according to factor shares. Through the recognition of different parts of the labor market the dependence of each on different production activities can be recorded. The simplest example is that the estate labor force depends essentially on the tea industry and to a lesser extent on rubber for its employment.

The incomes of the six factors of production are laid out in the first six columns. Thus all urban labor income (1,673) goes to ur-

## TABLE 4

## A SOCIAL ACCOUNTING MATRIX FOR SRI LANKA, 1970 (in millions of rupees)

A social accounting matrix for Sri Lanka, 1970
(in millions of rupees)

| Receipts | | | | Expenditures | | | | | | | | | | | | Expenditures | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | | | | | | 2 | | | 3 | 4 | | 5 | 6 | | | | | | | | | | | 7 | |
| | | | | Factors of production | | | | | | Institutions | | | Institutions | | | | Production activities | | | | | | | | | | | | |
| | | | | Labour | | | Other | | | Current accounts | | | Current accounts | | | | | | | | | | | | | | | | |
| | | | | | | | | | | Households | | | | | | | | | | | | | | | | | | | |
| | | | | Urban | Rural | Estate | Housing | Other private | Public | Urban | Rural | Estate | Private corporations | State corporations | Government | Combined capital assets | Tea | Rubber | Coconuts | Rice | Other agriculture | Food and drink | Other industry | Trade and construction transport | Trade and private transport services | Private services | Government services | Rest of the world | Totals |
| 1 | Factors of production | Labour | Urban | | | | | | | | | | | | | | 5 | 5 | 3 | 25 | 76 | 46 | 182 | 81 | 414 | 278 | 558 | | 1673 |
| | | | Rural | | | | | | | | | | | | | | 43 | 158 | 67 | 706 | 247 | 66 | 289 | 158 | 487 | 278 | 718 | | 3185 |
| | | | Estate | | | | | | | | | | | | | | 526 | 133 | 11 | | 6 | 4 | 2 | 6 | 8 | 12 | 6 | | 711 |
| | | Other | Housing | | | | | | | | | | | | | | | | | | | | | | | 633 | | | 633 |
| | | | Other private | | | | | | | | | | | | | | 13 | 24 | 442 | 282 | 1259 | 184 | 604 | 742 | 1426 | 123 | | -113 | 4984 |
| | | | Public | | | | | | | | | | | | | | | | | | 11 | 12 | 108 | -6 | -1 | 73 | | | 174 |
| 2 | Institutions | Current accounts, Households | Urban | 1673 | | | 137 | 662 | | | | | 434 | | 81 | | | | | | | | | | | | | 8 | 3003 |
| | | | Rural | | 3185 | | 330 | 3028 | | | | | 203 | | 181 | | | | | | | | | | | | | 6 | 6901 |
| | | | Estate | | | 711 | 31 | 30 | | | | | 7 | | 6 | | | | | | | | | | | | | 6 | 791 |
| 3 | | Current accounts | Private corporations | | | | 135 | 1298 | | | | | | | 87 | | | | | | | | | | | | | -16 | 1443 |
| 4 | | | State corporations | | | | | | 174 | | | | | | 237 | | | | | | | | | | | | | | 411 |
| | | | Government | | | | | | | 369 | 184 | 4 | 272 | 104 | | 313 | 33 | 4 | 14 | 10 | 19 | 288 | 216 | 66 | 130 | 76 | 29 | 94 | 2234 |
| 5 | | | Combined capital account | | | | | | | 519 | 807 | 11 | 527 | 307 | 43 | | | | | | | | | | | | | 425 | 2639 |
| 6 | Production activities | | Tea | | | | | | | 14 | 85 | 7 | | | | -66 | | | | | | | | | | 2 | 2 | 839 | 884 |
| | | | Rubber | | | | | | | | | | | | | 26 | | | | | | | 8 | | | | | 341 | 374 |
| | | | Coconuts | | | | | | | 84 | 208 | 27 | | | | 29 | | | | | | 239 | 8 | | | 6 | 4 | 2 | 677 |
| | | | Rice | | | | | | | 188 | 780 | 102 | | | | 106 | | | | 1082 | | | 2 | | | 16 | 18 | | 2342 |
| | | | Other agriculture | | | | | | | 367 | 880 | 139 | | | | | 11 | 1 | | 2 | 95 | 63 | 34 | 3 | | 39 | 16 | 106 | 1848 |
| | | | Food and drink | | | | | | | 253 | 841 | 82 | | | | 37 | | | | 8 | 11 | 24 | 188 | | | 29 | 6 | 94 | 1276 |
| | | | Other industry | | | | | | | 258 | 621 | 69 | | | | 72 | 87 | 24 | 9 | 36 | 66 | 48 | 604 | 417 | 172 | 37 | 66 | 241 | 2790 |
| | | | Construction | | | | | | | | | | | | | 1608 | | | | | | | 1 | | 7 | 50 | 82 | | 1748 |
| | | | Trade and transport | | | | | | | 410 | 1074 | 122 | | | | 184 | 80 | 10 | 8 | 44 | 23 | 85 | 249 | 206 | 96 | 42 | 88 | 203 | 2848 |
| | | | Private services | | | | | | | 406 | 820 | 85 | | | | | 11 | 3 | 7 | 16 | 1 | | 4 | 9 | 28 | 55 | 37 | 287 | 1877 |
| | | | Government services | | | | | | | | | | | | 1848 | | | | | | | | | | | | | | 1848 |
| 7 | | | Rest of the world | | | | | | | 207 | 741 | 143 | | | | 364 | 76 | 12 | 10 | 32 | 83 | 204 | 370 | 66 | 70 | 133 | 43 | | 2522 |
| | | | Totals | 1673 | 3185 | 711 | 633 | 4984 | 174 | 3003 | 6901 | 791 | 1443 | 411 | 2234 | 2639 | 884 | 374 | 677 | 2342 | 1848 | 1276 | 2790 | 1748 | 2848 | 1877 | 1848 | 2522 | |

ban households. For rental income and private profits the allocation is more difficult: it depends on who owns the corresponding factors, since rents go to the owners of housing while profits go to the owners of capital, i.e. to companies or to the household owners of unincorporated businesses.

The current accounts for institutions show three sorts of household, two types of companies, and government. The column 7 sums for the institutions show their total incomes. These come primarily from supplying factor services, but there are also incomes received from other institutions (i.e. transfer payments). These are primarily profit distributed by companies, benefits paid by government, and tax payments to government.

## Conclusions and Policy Inferences

The three most important contributions which the present approach appears to make to the planning process are: (a) the specification of a system for classifying and collecting empirical information in a way appropriate to the planning of the economic and social development process; (b) the construction of the modular conceptual framework which brings out explicitly, in a consistent way, the interdependence between the various parts and variables of the complete system; and (c) the incorporation of policy means and policy objectives in the framework. Potentially, this last contribution permits the identification of appropriate development strategies and, more generally, the simulation of the likely effects of alternative policy packages on the policy objectives within a dynamic setting. All three contributions are highly inter-related.

As Table 3 illustrates, the planning framework embraces a number of modules (or subsystems), each with its own set of relationships between variables and corresponding accounts. In turn, the various subsystems are connected by relationships which act as links between one set of variables and another. The SAM provides the appropriate classification, the organization schema and the underlying algebra for this analytical framework. The values of all endogenous variables can be generated as functions of a set of exogenous variables (shown in italics in the table) representing the initial condition and the policy measures under the control of government.

It is because the initial conditions prevailing among developing countries can differ significantly in terms of such factors as the initial resource endowment and pattern of ownership, the stage of development, the institutional setting, and the availability of information that a flexible approach to planning is required. It has already been seen that an important advantage of the modular approach is that it provides much scope for flexibility in the specification of the planning framework.

Given this diversity of settings faced by developing countries and the multiplicity of objectives, such as growth and poverty alleviation, which the planner has to focus upon, a modular consistency approach is likely to be the most useful operationally. One major advantage of the consistency framework is that it allows the effects of alternative policy packages on the policy objectives to be traced out in the form of what might be called a "policy navigation table."

Since we are interested in improving the standard of living of individuals and reducing poverty, it is essential to link our performance index (i.e. the geometric mean income) to the basic needs and wants of households, particularly the poor ones. Given a certain society and environment, it is possible to specify minimal requirements for a whole bundle of goods and services, and to trace over time the consequences of alternative policies on the growth rate of living standards of different household groups. This process might reveal, among other things, the undesirable effects of too great an emphasis given to equity today on the growth and equity of tomorrow--particularly if the policy were based mainly on consumption transfers.

Consequently it would be quite meaningless from a planning standpoint to limit oneself to a static framework and a performance measure which focused only on the distribution among individuals of a fixed basket of goods. The fact that growth is not seen as a sole objective of development in no sense implies that it is irrelevant. On the contrary, growth is essential if poverty is to be relieved, especially in many parts of South Asia where the current level of production is simply not sufficient to provide a decent standard of living for everyone even if total income were to be equally distributed. A trade-off can exist between growth and equality over time.

A major contribution of this planning framework is that the variables in the respective subsystems are broken down in an operationally useful way, while the SAM provides a comprehensive survey of the complete classification scheme and of the transformation, or mapping, between classifications used in the different modules. Thus it can be recalled, following the interdependent sequence represented in Figure 2, that households are divided into relatively homogeneous groups according to criteria such as socioeconomic factors, regional considerations and similarities in terms of wealth, income and consumption patterns. Wants are broken down into meaningful categories to reflect food, clothing, shelter and other requirements. Commodities, in turn, are divided into classes permitting an easy mapping of them as means for satisfying the needs and wants expressed by the household groups.

Next in our sequence, production activities are defined along criteria such as types of commodities produced, form of organization (i.e. formal, informal) and technology used. In addition, a distinction is made between, first, goods and services which are produced for the market, and second, those which are not and hence lead to imputed (as opposed to actual) income. The production of goods and services requires both intermediate and primary factors of production. The derived demand for the latter generates value added which represents the major source of income accruing to the factors of production. These factors are broken down according to occupational and skill characteristics with regard to labor, according to age and other technological factors for capital inputs, and finally, according to agronomic and regional criteria with respect to land. Hence, the value added returns accruing to these inputs from the production activities generate a factorial income distribution which, finally, can be mapped into the corresponding distribution of income over household groups and other institutions (government and companies). The circular framework in Figure 2 is then completed by providing the various categories of households and other institutions with the incomes which determine, in turn, the expenditures pattern of the latter.

Some observations are in order with regard to the operational usefulness of this framework and the corresponding data system for formulating development strategies. First, it should be clear by now that it provides a systematic and consistent way of identifying the initial conditions which exist in an economy. Obviously, an appropriate and thorough specification of the initial conditions yields a policy diagnosis and foundations upon which a development strategy can be built. Different initial conditions will require different packages of policy measures, even where the objective function is similar. The social accounting matrix thus suggests the kind of data needed for policy formulation, and the form in which this information might be presented. Hence the complete classification scheme that underlies the various subsystems of the SAM provides gudelines to statistical offices regarding the specific types of information that policy makers should seek. Such guidelines may be of great assistance to statistical offices in the process of designing surveys and censuses, and in gathering and tabulating other types of information.

A second major advantage of our framework is that it allows a certain amount of policy simulation. The effects of alternative policy packages on the whole system over time can, as noted earlier, be traced out to form policy navigation tables. This can be done with or without a specified policy objective. When one or more objectives are specified, they can then be applied to the "navigation tables" to find what might be termed a "policy feasibility space" within which an appropriate strategy can be chosen. This approach to planning is thus quite flexible.

Furthermore, the framework seems applicable to countries following very different economic and political systems, from an essentially mixed economy to a controlled economy. The only qualification is that government should have an interest in exploring the fulfillment of basic needs over time. The framework can to a limited extent estimate the trade-off between an improvement in the current standard of living of the different household groups and future improvements. In a more general sense, the policy navigation tables illustrate quantitatively the growth paths in the living standards of the various household groups. By revealing to the policy maker the extent to which basic needs can be fulfilled over time, the ultimate choice will depend, of course, on his distributional time preference.

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Editorial Note. This extract is intended to give readers a very general idea of what a social accounting matrix is, what it looks like in a static form, and what it could do if completed with appropriate data. We cannot briefly explore the dynamics, and all the functional relationships within as well as among modules. Thus we cannot illustrate how it could be used to form a "policy navigation table," and to locate effective policies combining growth and anti-poverty objectives.

U.S. GOVERNMENT PRINTING OFFICE: 1980—310-928/1

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VOL. XVIII • NO. 2 • APRIL 1980

# DEVELOPMENT DIGEST

S18.33:

The DEVELOPMENT DIGEST is prepared for the Agency for International Development by the National Planning Association, a private, non-profit organization in Washington, D.C.

We would appreciate comments of an editorial nature and suggestions of material for possible inclusion in the DIGEST. Please address:

Editor: DEVELOPMENT DIGEST
National Planning Association
1606 New Hampshire Avenue, N.W.
Washington, D.C. 20009

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 2, 1966.

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# DEVELOPMENT DIGEST

A quarterly journal of excerpts, summaries, and reprints
of current materials on economic and social development

Gordon Donald, Editor; Anthony Pearce-Batten, Associate Editor;
Lowell Shaffer, Digest Secretary
Prepared by the National Planning Association

for

Agency for International Development, U.S. Department of State

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# Results of Questionnaire Sent to Readers of Development Digest

A series of questions was put on a card in the first page of the January 1979 issue of the Development Digest in such a way that readers could remove the card, answer the questions, and mail it to AID (the Agency for International Development) in Washington, U.S.A. The questions were: first, a list of different subjects, asking readers to check those they would like to see in future Digests, and double check those that interested them most strongly; and secondly, a few general questions on the Digest content and its usefulness to readers. Two hundred and ten people responded, and the results are shown in Table 1.

If the opinions expressed here are representative of our general readership, some inferences may be made. Perhaps the most important is that Digest readers do have a variety of different interests, so that the journal should continue to supply a diversity of subjects: this seems to indicate that we should try to cover different topics in each issue (as we do), as well as a range of different subjects during a year. There are some patterns in the amounts of interest shown in these responses. The two most popular subjects, Strategies for Development, and Planning-Project Appraisal, point to a strong concern with the directions and purposes of development and the way it should be guided. Closely behind these two comes Agriculture which, together with subjects such as Village Technology, Social Change and Marketing-Cooperatives suggest that rural development has a relatively high priority in the minds of respondents. Employment Generation and Population are two basic areas of concern. And in the upper-middle level of priorities are technological subjects like Energy Alternatives, Science-New Technology, Agricultural Research, and Nutrition. These areas, one may assume, are of interest to the largest numbers of our readers and should be pursued further.

The subjects in the middle and lower parts of the list in Table 1, from Education on down, represent more specialized economic sectors: they each have a following among readers, but less widely. (The subject of Women belongs in this group, it appears.) Finally, the broader or less focused topics--philosophical, anthropological, cultural/historical --attract fewer of our readers, though not a negligible number, and may be taken up occasionally. In addition, 43 people proposed subjects that we had not put on our list; but these are too diverse and numerous to summarize here. Answers to the final questions also suggest avenues of substantial reader interest.

The respondents to the questionnaire represent 40 different nationalities. Some of the larger country groups were: Indonesians, Pakistanis, Filipinos, Brazilians, Indians and Thais. Their occupations are almost as diverse, with 36 categories: university professors were the biggest group, followed by economists (largely in government) and librarians. But there were many other kinds of people who responded--bankers and financial managers, agriculturalists, engineers, town planners, businessmen, project managers and more narrowly defined specialists.

Table 1 - Results of January 1979 Questionnaire
(210 Responses)

| Subject Areas of Interest | Number Interested* | Strongly Interested* |
|---|---|---|
| Strategies for Development | 146 | 33 |
| Planning; Project Appraisal | 137 | 24 |
| Agriculture | 133 | 29 |
| Village Technology | 102 | 18 |
| Employment Generation | 101 | 17 |
| Population Problems | 101 | 10 |
| Social Change | 97 | 7 |
| Marketing, Cooperatives | 92 | 7 |
| Science, New Technology | 84 | 7 |
| Agricultural Research | 83 | 16 |
| Energy Alternatives | 81 | 10 |
| Nutrition | 77 | 14 |
| Education | 77 | 12 |
| Irrigation, Water | 73 | 10 |
| Public Administration | 73 | 9 |
| Industry | 73 | 6 |
| Urbanization | 72 | 6 |
| Inflation | 70 | 9 |
| Health | 70 | 7 |
| Trade Policies | 68 | 9 |
| Foreign Investment | 67 | 7 |
| Women | 67 | 7 |
| Credit | 66 | 5 |
| Finance, Taxation | 63 | 5 |
| Entrepreneurship | 62 | 9 |
| Communications, Media | 56 | 7 |
| Foreign Exchange | 56 | 7 |
| Housing | 55 | 3 |
| Transportation | 54 | 4 |
| Resources: Metals, Forests, etc. | 48 | 5 |
| Anthropological Findings | 47 | 1 |
| Philosophical; Basic Needs, Human Rights, etc. | 46 | 7 |
| Cultural, Historical | 38 | 0 |

| Reader Preferences | Number Checked |
|---|---|
| More recent research results | 129 |
| More experiences in other countries | 116 |
| New thinking on old problems | 97 |

| Readers find the Digest: | |
|---|---|
| Very useful | 111 |
| Quite useful | 73 |
| Not useful, Occasionally useful | 3 |

*"Number Interested" includes those with both single or double checks; "Strongly Interested" are those with double checks.

A second questionnaire was sent in the summer of 1979 to a smaller group of people, including those who had answered the first questionnaire plus some of the American and European subscribers and a random selection of others from the Third World. These questions dealt with various aspects of the Digest other than subject matter, such as the ways it can be used and its composition or presentation. Answers to these questions appear in Table 2; there were 155 responses.

As Editor of the Development Digest since 1968, I would like to say a few words to the many readers who have taken the trouble to send in answers to either or both of these questionnaires. I know that the Agency for International Development is most appreciative of your assistance, and I would like to add my expression of gratitude. Normally, I send my ideas around the world after guessing at what may be of interest to people in Asian, African and Latin American countries, but without any way of knowing whether or not I have guessed right. It is therefore good to hear the kind words that many of you have said; and critical statements can become more valuable for my thinking.

For example, I very often wonder whether certain English words to be used in the Digest will be difficult for the majority of my readers whose first language is not English; apparently this is not true, at least for most of those sending in their opinions. Similarly, the difficulty of understanding technical terms should not be too much of a deterrent to publishing new thinking in various fields (if one tries to explain them). Most respondents do not find the articles too "theoretical," but some do. On the question of long vs. short articles, and on the thoroughness of treatment of (fewer) subjects versus greater variety, there are clearly two schools of thought; but it appears that those who favor brevity and thoroughness are somewhat more numerous. (One reader pleaded for more humor and some cartoons--even though he recognized that the journal "is for professionals.") There is evidently an interest in book reviews; and some readers suggested the addition of book lists on a subject, or of more explanatory introductions. Some like the pictures, some don't; most respondents approve of the format, but some speak out against the appearance of the journal. There is general agreement on the desirability of articles by developing country authors, and on the value of case studies--reflected also in the commentary.

The comments by respondents are rather different from one another, but there seem to be a few common themes. Many readers find the Digest expanding their horizons, keeping them informed on countries other than their own and in fields they would not ordinarily look into. Some speak of a stimulus to ideas. In a number of cases, one copy of the journal will be passed around to quite a few people. While recognizing that many readers' opinions did not find their way into this survey, I find much that is useful to me, and I will attempt to provide more of what readers want. Perhaps one cannot keep everyone happy, but the attempt to do what one can is much encouraged by this display of interest.

Gordon Donald, Editor

## Table 2: Responses to Second Questionnaire - Summer 1979
(155 Responses)

1. How does the *Development Digest* benefit you:
   a) Useful and relevant to your work? 137-yes/7-no.
   Have any proposed approaches worked effectively? 74-yes/18-no.
   Were they relevant to field conditions? 83-yes/25-no.
   Without practical application for you? 27-yes/62-no.
   b) Useful in putting developmental problems of your country into perspective? 109-yes/12-no.
   Learning about similar problems other countries are having? 140-yes/1-no.
   c) Useful in promoting professional communications? 119-yes/19-no.
   d) Serves educational purpose; keeps you apprised of latest developments? 142-yes/3-no.
   e) Useful in some other way? 80-yes/9-no. Please explain.

2. Do you read the *Digest*:
   a) Some of it? 111. All of it? 26. Skim through it? 53.
   b) As soon as you receive it? 99. Within 1 to 2 months? 54.
   Several months later? 6. Put it on a shelf, look at it occasionally as a reference document? 74.
   c) Would you subscribe if there was a minimal charge? 106-yes/29-no.

3. Do you pass it on to your colleagues? 117.
   How many read it? (Various numbers.)

4. Questions relating to English language:
   a) Do you find the English words used in the articles hard to understand? No-135. Sometimes-15. Often-0.
   b) Much of the new thinking in economics and social science is presented in technical terms. Editing can help, but cannot eliminate the problem. Would you prefer that *Digest* articles avoid such difficult subjects? 25-yes/87-no.
   Have fewer of them and more "readable" items? 54-yes/46-no.
   Even try harder to get the most advanced thinking? 73-yes/32-no.

5. Do you have suggestions for changes in content and format?
   a) Do you like the present format? 121-yes/20-no.
   b) Would you prefer a greater variety of subjects in one issue? 60-yes/80-no.
   c) Would you prefer a more thorough treatment of fewer subjects? 72-yes/55-no.
   d) Are the articles too theoretical? 32-yes/98-no.
   Should we present more case studies? 113-yes/26-no.
   e) Would you like to see: more book reviews? 87-yes/35-no.
   More pictures or graphs? 69-yes/43-no.
   More long articles? 39-yes/57-no.
   More short articles? 78-yes/33-no.
   f) Would you like to see more articles by developing country authors? 121-yes. Fewer? 7.

6. Have you or your friends had any problems obtaining copies of the *Digest*? 30-yes. Please explain.

7. Would you like to continue to receive the *Digest*? 155-yes/0-no.

# FOOD SUPPLIES

LUNCH TIME AT A
DAY NURSERY SCHOOL
IN RANGOON, BURMA
(PHOTO: FAO, BY S. PUNNAG)

# Overview of the World Food Supply Problem

Sterling Wortman and Ralph W. Cummings, Jr.

[The food supply problems of a world with fast growing populations can be effectively tackled with accelerated programs of intensified agriculture--if governments have the will to do so. The basic strategy, and some of the obstacles to overcome, are outlined.]

That the world food situation today is serious, even precarious, is well established. That world population was only 2,000 million in 1930, reached 3,000 million in 1960, and now stands at over 4,000 million is a fact. That man's numbers will reach 6,000 million or more during the next 25 years is a near certainty. That food deficits in many countries are reaching dangerous levels is well documented. That hundreds of millions of people in several scores of nations still live in abject poverty, plagued by hunger or malnutrition, is undeniable.

The complexity and magnitude of the task notwithstanding, for the first time in history it is now possible for many governments to act against both hunger and poverty. A decade ago--or probably even 5 years ago--success would not have been possible for most countries. In making this assertion, we are quite mindful of the words of U.S. President Truman in the now-famous "Point Four" of his 1949 inaugural address: "Fourth, we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas. More than half the people of the world are living in conditions approaching misery... For the first time

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in history, humanity possess the knowledge and the skill to relieve the suffering of these people." One may ask, then, why it is any more realistic to claim today that governments could successfully attack hunger and poverty than it was three decades ago? There are good reasons, and a strategy for action is emerging. But to understand the strategy, one must understand the nature of the problem.

## Three Eras of Agricultural Development

Over thousands of years, people have practiced subsistence or traditional agriculture. First, there were the hunters and gatherers of food; then, as groups took up sedentary farming, there began the long and slow process of the evolution of countless systems of crop and animal production, many of which persist today. The productivity of such traditional farming systems is largely limited by fertility of the soil and characteristics of climate. As populations have burgeoned, particularly in recent decades, landholdings have been divided and subdivided among heirs, so that in many of the more populous nations farms are tiny by North American standards; for example, in parts of Indonesia, the average holding is less than one-half hectare. The evolution, over thousands of years, of traditional farming systems--which the great bulk of the world's farmers still use today--constitutes a *first era* of agricultural development.

A *second era* of agricultural development--science-based and industry-supported--has largely occurred in this century. During the past 75 years we have witnessed an agricultural revolution in which the now-industrial nations pioneered and excelled. That revolution has been characterized by the creation, by genetic manipulation, of more efficient crop varieties and animal strains; the development and use of chemical fertilizers and of science-based means to control diseases and insect pests; the development of agribusiness; the expansion of road networks, power grids, and use of farm machinery; the development of means of mass communication of information; and of course the ever greater skill of farm entrepreneurs in intensified agriculture. Rising economic demand for goods and services has spurred this remarkable era of ever higher yields per unit of area, time, or investment. Science and industry have provided the building blocks for today's advanced agricultural systems, but let us not forget the role of the farm producer in the equally sophisticated task of putting together for the individual farm all the components of productive and profitable systems.

We are now entering a *third era*, the era of accelerated, forced-pace agricultural and rural development efforts. Scores of nations in serious difficulty are looking for ways to increase food production and incomes and raise living standards among the rural masses, not in 50 or 75 years but in 10 or 15. The incentives for action are becoming clear: they involve urgent matters of political stability and national security, as well as economics.

First, government leaders are increasingly aware that, unless they take steps to develop their rural areas through widespread involvement of the rural poor, they will likely face unrest, violence, even revolution. With advances in mass communication and transportation, long-neglected people are recognizing that a relatively small fraction of the citizenry is enjoying the comforts of life. Yet they see little hope for themselves or for their children. They are responsive to any ideology which will offer to them those things they hold most important: food, clothing, health care, education, security--and hope.

Second, with the 1973-74 disappearance of large crop surpluses in the U.S. and other countries and the resulting high prices, governments have learned that they can no longer count on continuing access to the cheap sources of food which enabled them to keep food costs low in their urban areas while neglect of their agricultural areas and people persisted. High food costs in international markets, which require substantial outlays of scarce foreign exchange, have for the first time forced some governments, for security reasons, to worry about increasing the productivity of their long-neglected small farms.

Third, governments are learning they can substantially expand their domestic markets for products of urban industry by extending science-based, market-oriented agricultural production systems among great masses of rural people. As farm families have access to greater disposable income through increased agricultural profits, they become purchasers of goods and services. Employment rises not only on farms but especially in rural trade centers.

This third era of agricultural development must involve concerted efforts to move into the countryside more aggressively and systematically with roads and power systems, with supply of inputs and arrangements for the marketing of agricultural products. Moreover, scientists must work directly in rural areas to create the more highly productive, more profitable farming systems which will contribute to the primary ingredient for rural development: increased income for large numbers of farm families.

Decreased rates of population growth must be achieved whereever necessary; otherwise there can be no long-term solution to the food-poverty-population problem. Economic development should contribute to the lowering of population growth rates, and successful efforts to get agricultural production up in the developing countries is central to economic development. Agricultural development efforts buy time for slowing population growth, and that time must be used wisely.

The task ahead. We must not underestimate either the complexity of the task ahead or the dedication to the efforts required. In mid-1975 the world population was about 4,000 million. About 2,000 million people will be added by the year 2000, about two-thirds of them in already heavily populated nations.

Before World War II, Latin America, Africa, and Asia were net exporters of grain--the staple food of most populations. By 1950 they had become net importers of about 5 million tons a year. By 1960 their net deficit had climbed to 19 million tons and by 1973 to around 47 million tons. Their combined deficit for 1976 was about 60 million tons. Unless the trend in production in developing market-economy countries improves, world production of cereals by 1985 is projected to fall short of demand by 100-200 million tons.

It is important to understand the nature and diversity of the countries where the problems of hunger and poverty are or will likely become most severe.

- Most developing countries are extremely poor. While in 1975 the per person gross national product (GNP) was US$7,060 in the U.S., $6,650 in Canada, and $2,620 in the U.S.S.R., there were 61 countries with GNP below $500 and 36 with GNPs of less than $250. Income levels among the masses of the rural people are well below the average in each of those countries.

- Many nations are small. In 1976 there were 161 nations or geopolitical entities with substantial local autonomy, and 78 had populations of 5 million or less; of these, 34 had fewer than 1 million.

- Many nations are newly independent. Of the 43 nations considered by the United Nations as "least developed" or "most seriously affected" by the recent economic crisis, 36 have become independent since 1945 and 29 of these since 1960.

The newer, smaller, poorer countries face most of the problems of the larger, older, developing countries and, in addition, they have severe problems in gaining access to trade, financial and technical assistance, and knowledge.

As colonial systems weakened, the cutting of political ties with major industrial nations was frequently accompanied by a loss of assured markets for exports or assured sources of needed imports. New trade relationships had to be worked out with the industrialized countries. Foreign commercial investment in local agricultural enterprises has generally become less attractive because of local opposition to management of domestic enterprises by foreign personnel. Small nations, whether newly independent or not, cannot expect to have the full range of scientific and other professional services required in all fields important to their development. They must usually rely heavily on external help. Each small entity finds itself jostling with a great number of other small entities for technical and financial assistance, and must attempt to fit the potential assistance to their particular needs.

Most of the newly independent nations were left with limited scientific or managerial capability to improve food production. In general, the colonial powers had done much to develop export crops and animal species destined for sale abroad. While the developing nations are dotted with centers for research on coffee, cacao, rubber, or jute, until a few years ago one could find few centers for work on wheat, maize, rice, the food legumes, the root crops, the vegetables, or other food crops. The basic food crops were neglected. It should be recalled, however, that in 1930 the world population was only 2,000 million, or half that of 1975; there was not the same population pressure on the land that exists today in most countries, and, until a few decades ago, the increasing food needs of those countries could be met by cultivating more land. But that option is disappearing--or is already gone in some areas.

In the governments of most low-income countries, the persons in authority are military men, lawyers, businessmen, physicians, engineers, economists, or religious leaders. Few understand agriculture or the technology and science which underlie it. Given the complexity and urgency of the task ahead, one can rightly ask, Is there any hope? The answer is yes, the world does have the capabilities, and the reasons why need to be understood. To a large degree, these capabilities have come into being during the past decade.

The basis for hope. The basis for hope rests on several factors. The world's leaders are becoming more aware of the problem. The physical resource base, particularly arable land and water, can permit a substantial increase in the intensity of cropping in most countries. Steps have been taken to begin to produce the crop strains and related technologies required to increase agricultural production in the tropics and subtropics, where most developing countries are. Fertilizers have become available in sufficient quantities and at low enough cost to allow their use to be extended to the food crops in the low-income countries. International assistance mechanisms exist which can provide funds and technical counsel for development efforts. Most of these efforts can be financed on a loan basis because investment in agriculture is at least as profitable as investment in airlines, manufacturing, or housing. It has been demonstrated that the developing countries can, if they will, successfully promote agricultural and rural development. It has been shown that the farmers will shift to new systems if these prove sufficiently productive and profitable. The will of governments to take action is growing. These factors, combined with the tremendous scope for increasing food-crop production in most developing countries, represent the basis for the statement that for the first time in history we now have an opportunity to deal effectively with the problem.

## The Strategy

A prime concern of the government of any nation, if that government is to remain in power, is provision of the fundamental requirements of its citizenry. Among those requirements are security, an adequate food supply, and the means for an improved standard of living. Central to progress in all poorer agrarian countries is increased productivity and prosperity of the rural areas.

In agrarian nations it is the many farmers with tiny landholdings, often in remote areas, plus those people on the coasts who depend upon near-shore fisheries and aquaculture for a livelihood, who produce the bulk of the food supplies. Usually, raising the productivity and income of these poor rural dwellers requires new high-yielding, science-based crop and animal production systems tailored to the unique combination of soil, climatic, biological and economic conditions of each locality. In short, the agricultural revolution which has undergirded the economic advances of the industrialized nations must be extended quickly and systematically to all areas of the poorer agrarian countries.

Two sides of the food problem. Increasing farm production to meet the needs of the rural family is important. But one objective of agricultural development must be to allow individual families to produce a surplus for sale, so that the total output of a locality exceeds total local requirements and permits sales in urban centers, other rural regions, or in international markets. Inputs required for higher productivity must be purchased and markets for products must be established. Thus, traditional farmers must be brought into the market economy. In this way they will become purchasers of larger amounts of goods and services, contributing not only to the vitality of enterprises in their rural trade centers, but also to the expansion of domestic markets for products of urban industry.

As increasing numbers of traditional or subsistence farms are brought into the market economy, they will require a range of services similar to those of other small businesses. Many of these services--input supply and marketing--can often be supplied most efficiently by private enterprise. Some, including development of improved farming systems and development of nonhybrid crop varieties, must be provided by government since private industry usually cannot recapture investments in such activities.

When we speak of the world food problem we often tend to oversimplify it. The immediate problem to be attacked is low agricultural productivity and lack of employment of great masses of rural people. Clearly there are two sides to the food problem: one is to increase production; the second is to create purchasing power among the hungry. The effort to increase crop and animal production on the hundreds of millions of family farms around the world gets at both sides of the equation. It is the only approach which does.

*Targeting on the small farmer*. Agricultural development is commonly organized to achieve local or nationwide gains in the production of particular commodities. Goals are normally expressed in terms of tonnages to be achieved or hectares to be covered in a given time, and these may be appropriate under some circumstances. But if such are the goals, agencies cannot be blamed for concentrating on the better agricultural regions, or working with large farmers, because those are the quickest and least expensive ways to achieve output or area-coverage goals. Until recently, there have been few direct attempts to help large numbers of small farmers to increase productivity and incomes, with numbers of farmers to be benefited as the goal. If such farmer-participation goals are not clearly stated, agencies will not undertake the difficult task of working with numerous small farmers, and they will continue to be by-passed. But, if efforts are aimed at the small farmers, all farmers will benefit, for the educated farm operators with large holdings are generally quick to adopt any advances which increase farm profitability. By casting the development net to involve small farmers, most farmers will gain.

*Meeting requirements for farmer participation*. Experience in many countries demonstrates that farmers will shift to more productive and profitable agricultural systems *if they can*. This applies to the relatively uneducated producers with small holdings as well as to those well-educated entrepreneurs with large farms. To enable farmers to participate in the market economy, a number of requirements must be met simultaneously. First, productive and profitable combinations of technology must be available. Second, the farmer must be instructed in their use. Third, necessary inputs (seed, fertilizer, pesticides, vaccines and feed supplements for animals) and credit must be available when and where the farmer needs them and at a price that allows a profit. Fourth, there must be markets for farm produce.

If any of these four requirements is lacking, farmers will not switch to more productive practices. Government efforts in the past have often centered on individual components such as supply of credit, or of seed, or extension services, with disappointing production results. Such failures usually stem from remaining weaknesses in the system, quite often in the technological component, or from markets or supply points that are too distant from farms, or from prices to farmers that are too low to allow a reasonable profit. Usually the fault for failure is not the farmer's; it lies in the design or execution of programs, including policy components.

Agrarian transformation. In many countries the institutional structure of agriculture, particularly the land tenure situation, is not conducive to developing a productive agriculture built on small farms, individually or collectively managed. Land tenure largely determines who benefits from increases in productivity. It influences the amount of the farmer's production by determining when he gets access to new technologies including the necessary inputs, and how much of the production he is able to retain. It shapes the distribution of employment opportunities in the agricultural sector. It influences the rural person's income and status in the community.

In some countries, governments are distributing state-held lands. And some individuals and corporations are beginning to divest themselves of extensive landholdings--some doing so, they say, while they still can. In other countries, however, land reform may be required. Distribution of land in itself will not lead to higher productivity unless the four requirements listed earlier also are met. Often these conditions do not exist and results of land reform programs remain disappointing.

Programs to increase the productivity and profitability of agriculture need not wait for land reform; many subsistence farms, or those with limited sales, could, through provision of necessary services (including supply of technology), produce larger surpluses than they do now--and without undue delay. However, in the absense of effective agrarian reform the results will never reach full potential in terms of either production or income distribution. This concept of a high density of farms owned and operated by families is broad enough to embrace independent farm units in a free-enterprise system, farm federations, cooperatives, and even the communes of the People's Republic of China.

Approaches to accelerated agricultural development. Development of agriculture and rural areas has taken many forms. Most offer some benefits and most have significant limitations. None alone is adequate.

New institutions have been established, and existing ones--such as planning agencies, research and extension organizations, universities or colleges and schools of agriculture, credit banks, supply and marketing organizations, farmer groups (including cooperatives)--have been strengthened with varying degrees of success. All are important, and such efforts must continue. If national progress is to be greatly accelerated, however, such institutions, and others public and private, must become directly involved in development programs, making concerted efforts in each farming district. Their contributions to development, rather than their own growth and prosperity as institutions, must be the measure of success. This will often require substantial modifications in their goals, their organizational structures, the qualifications of their staff, the arrangements for integration of their efforts, and their reward systems.

The most dramatic advances of recent decades have involved commodity production programs. In the developing countries there have been many instances of success--particularly with plantation or export crops --involving synchronization of production, research, and marketing. More recently there have been successes with basic food crops such as wheat in India, Mexico, Pakistan, and Turkey; rice in Colombia, India, Pakistan, and the Philippines; and maize in Kenya.

Another tactic now being widely employed is defined-area campaigns to achieve widespread gains in the productivity and incomes of rural people. In a particular locality this approach may be limited to intensive efforts to increase the productivity and profitability of one or a few commodities, or it may encompass comprehensive attempts to improve agriculture, along with education, housing, and health care, as well as to provide nonfarm sources of employment, through "integrated development." Defined-area development builds understanding of a rural community--its resources, the aspirations and activities of the people, its problems, and its potentials--and permits subsequent changes in the community to be measured. The ability of public and private agencies to cooperate can be determined, and weaknesses can be corrected. Innovations can be tested, and errors minimized, prior to wider-scale application. Moreover, such defined-area programs allow staff, through work with farmers and others, to become skilled in the solution of farm-level problems.

Successful efforts to force the pace of agricultural development must involve simultaneous provision of all necessary services, locality by locality--roads, markets, prices, input supply, and research. This will require reorientation and synchronization of the activities of diverse government agencies and of private industries, and decentralization of marketing and supply systems. To be effective at local levels, synchronization or coordination must occur at every level of government, including the top levels of ministries. A number of nations are seeking mechanisms by which to facilitate such synchronization.

The most comprehensive and desirable approach to accelerated development is a combination of commodity-oriented and defined-area efforts, supplemented by the strengthening of relevant institutions and attention to synchronization of the many services required for the success of either approach. It is important to note that the most effective way to improve institutions is to involve them in purposeful, fast-moving development efforts. The alternative of building institutions with the expectation that somehow they will later contribute to rapid development generally has been disappointing. While staff members may be well educated, they will lack the competence which only prior experience in development programs can provide.

Before national, comprehensive, accelerated agricultural development programs begin, long-term (15- to 20-year) goals should be established. This will provide the framework for shorter-term (say, 5-year) plans. At best, agricultural development is slow and involves large numbers of biological and social variables. It is important that such efforts be made in the right direction. Long-term goals cannot be precise, for no one can foresee all problems and potentials with clarity. Much planning must be based on the judgment of knowledgeable individuals, bolstered by experimental evidence to the extent possible. This will require the joint efforts of political leaders, planners, businessmen, industrialists, and persons of vision in the various agricultural specialities.

Three nonsolutions. Three often-mentioned "solutions" are important but do not address the basic causes of the world food problem. First, increased production in North America and by surplus-producers elsewhere will not contribute directly to the solution of the world food problem. Poor countries can ill afford to pay for food imports. Moreover, their deficits are growing so fast that neither North America nor others can possibly afford to provide free or subsidized food on the scale which soon will be required if developing countries are unable to speed agricultural development.

Second, large-scale mechanized crop production in most of the densely populated developing countries is not a practical solution to their food problem so long as the hungry have no way of getting more money to buy food. Moreover, large-scale mechanized farming generally is less productive per hectare than is "gardening," which can be practiced on small farms with abundant labor supply. Mechanized agricultural systems raise productivity per man-year and are highly productive otherwise, but most poor countries need labor-intensive systems.

Third, production of synthetic foods, single-cell protein, or other manufactured food products is not an answer to the world food problem. Here again the hungry have no means by which to pay for food of any kind, and such items are too expensive for free distribution on the scale which would be required.

Obstacles to overcome. One might wish that accelerated agricultural development were a simple matter that men of vision, authority, and good will could with confidence set in motion at once. Sometimes, unusual opportunities for large-scale achievement do occur, as when India launched the High-Yielding Varieties Program in 1964, when the Philippines started its "Masagana 99" campaign, or when Turkey intensified wheat production in her coastal areas. Similar opportunities no doubt will continue to arise, but such instances will be insufficient. Rather, governments must establish long-range national goals and create mechanisms and conditions for broad and rapid change in desired directions. They must place responsibility in the hands of individuals prepared to achieve ambitious targets, and then sustain long-term efforts. And international assistance agencies must support enlightened governments in such endeavors.

The wide range of barriers to the acceleration so urgently needed in so many countries must be surmounted.

- Not all national governments have the will to invest in agricultural development. The high financial returns to investment in agriculture often are not made known to national authorities in language they understand. Moreover, food aid--food sold at concessional rates or donated--if often used for continuing support of governments which neglect their rural problems.
- Development efforts are often fragmented. Responsibilities are divided among ministries or among departments within ministries. Capital and technical assistance is often provided through a series of scattered and uncoordinated projects.
- Individuals in developing countries who are attracted to agricultural development programs often are poorly trained and do not have farm-level experience.
- Too few of the technical assistance personnel from the developed countries are experienced in planning and implementing programs to accelerate agricultural development.
- Conservatism predominates among scientists in both the developing and developed countries. Disciplinary rather than problem-solving orientations persist. Laboratory work is of higher prestige than farm-level research and action programs. In-service training receives minor attention.
- The literature on agricultural development is often only remotely relevant to the problems that program practitioners must face.

A new level of effort required. The task ahead is vast and complex. It requires concerted work by individuals of considerable scientific and managerial ability--at least equivalent to those of the research and development efforts undergirding space programs. The creation of new crop varieties and associated cropping systems will require, both at international centers and in national research programs, capable plant breeders, agronomists, soil specialists, plant pathologists, entomologists, animal scientists, biochemists, and economists, to name a few. They must tailor the crops and cropping systems to the ecological, climatic, and soil conditions of every season of every region of every country.

Decentralized systems must be devised to supply the inputs, fertilizers, pesticides, water, and credit to large numbers of farmers at low cost, and these must be established in a hurry. There must be improved marketing systems, including arrangements for the purchase, transport, processing, and sale of farm products. Industry must be involved in preservation, storage, supply of quality seed, and many other aspects of modern market-oriented agricultural systems. In each country attention must be given to means of involving every relevant institution--public and private--in direct efforts to lift productivity, incomes, and living standards in rural areas. This calls for individuals who understand how national systems can be synchronized to achieve maximum progress at lowest cost.

The old idea that the U.S. or other countries could transfer agricultural know-how to other countries wholesale is a myth. Much technology, of course, is transferable. However, the idea that industrial countries could simply send farmers or extension specialists to the poor countries to show them how to farm, and thereby raise yields, has now been set aside. Such farmers and extension agents generally are highly competent people, but most of the temperate-climate farming practices in which they are skilled simply will not work in developing countries. The reason is that such prerequisites as efficient crop varieties, disease and insect-control practices, and means of preventing animal diseases are not yet available. The sophistication of the efforts required must not be underestimated.

Every government must be responsible for the food supply of its own people and for the development of its rural areas. Only the individual government can determine amounts to be imported or produced locally. Only the government can set the policies, strengthen the institutions, and reach the farmers and other rural people. Outside agencies can assist, as they must wherever governments are committed to rural progress and outside help is welcomed, but that is all they can do.

The challenge of increased food production is urgent for all. But production of food in itself is not enough. The hungry have no money, and until their purchasing power is increased, giving them access to food as well as other necessities, there can be no solution to the world food problem.

In discussing strategies for advances in rural areas, one must remember that increasing agricultural productivity and prosperity in the countryside is not a panacea for all the economic and social problems of a nation. But rural progress will be crucial to the general development of most nations. Those responsible nationally for establishing goals, allocating resources, and implementing programs of work must achieve a balance among the many competing demands upon national resources. Our appeal is not for exclusive attention to agriculture, for that would be naive; rather, it is for greater investment in agriculture and other means of increasing the productivity of rural dwellers, and for substantially improved effectiveness of efforts already under way. For the first time in history the world now appears to have the capability of dealing effectively with the difficult problems of hunger and poverty. The future of any nation is clearly entwined with that of nations elsewhere. Clearly the wisdom of choices in the immediate future will markedly affect the nature of the world in which the next generations will live. And, while the food-poverty-population problem is massive and complex and will be extremely difficult and time-consuming to resolve, the existence of new capabilities provides a magnificent opportunity, perhaps a fleeting one, to deal with it effectively--if governments have the wisdom and the will to act.

[Extracted from Chapter 1 of To Feed the World: the Challenge and the Strategy. Copyright © The Johns Hopkins University Press, Baltimore, Maryland, 1978.]

# Rapid Growth in Food Production in 16 Developing Countries, 1961-76

Kenneth L. Bachman and Leonardo A. Paulino

[An examination of the countries which have shown the most rapid and consistent increases in production of staple foods between 1961 and 1976 indicates a variety of different reasons for their success. This article provides a general review of the sources of their growth.]

Food production in the developing countries with market economies (DMEs) did not increase satisfactorily during the past 15 years. For all 94 DMEs, total food output during 1961-76 expanded at the rate of 2.6 percent a year, barely keeping abreast of overall population growth, and failing to attain levels that could also meet increases in demand due to the rising incomes and nutritional requirements of the populations of these countries.

In 53 of these countries the growth in staple food production fell behind population growth, representing a worsening of the food problem. In 38 of those 53 countries, the average annual increase in food production was less than 1 percent, compared with their 2.4 percent a year growth of population. On the other hand, of the 41 DMEs where food production expanded faster than population, 24 achieved relatively high production growth rates of 3.3 percent or more in 1961-76. The annual rate of growth of staple food output in these rapid-growth countries averaged 3.9 percent, which well exceeds their population growth of 3.0 percent a year. The average annual growth rates among these country groups were as follows:

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|  | Number of Countries | Food Production | Population | Per Capita Food Production |
|---|---|---|---|---|
| Rapid-growth | 24 | 3.9% | 3.0% | 0.9% |
| Medium-growth | 32 | 2.7 | 2.5 | 0.2 |
| Slow-growth | 38 | 0.9 | 2.4 | -1.5 |
| All DMEs | 94 | 2.6 | 2.6 | 0.0 |

Of the 24 rapid-growth countries, 16 were selected for this study: Brazil, Colombia, El Salvador, Ghana, Iran, the Ivory Coast, Malaysia, Mexico, Morocco, Pakistan, the Philippines, Sri Lanka, the Sudan, Thailand, and Tunisia. These represented 99 percent of staple food production and 97 percent of population of the group of 24 in 1976. This study focuses on the sources of growth and changes in the pattern of food production in these 16 countries. Spread over the world's four geographical regions, these countries exhibit wide differences in natural and demographic features and in patterns of agricultural and economic development.

Most of these rapid-growth countries belong to the middle- and high-income groups of DMEs. Only three (Pakistan, Sri Lanka, and the Sudan) had incomes below US $300 per capita gross national product (GNP) in 1976. Of the other 13 countries, Brazil, Iran, and Mexico had a per capita GNP exceeding US $1,000. In these three countries, agriculture accounted for 10 percent or less of the 1976 gross domestic product (GNP), whereas in all but two of the remaining countries it accounted for 25 percent or more. Per capita income rose 2 percent or more per year in most of the rapid-growth countries during the 1961-76 period.

## Trends in Rapid-Growth Countries

Growth in population and income per capita significantly increased the demand for staple foods in the study countries. The domestic use of staple foods in these countries increased by 61 percent between 1961-65 and 1974-76, or roughly 1 percent per capita a year. Per capita dietary energy consumption also generally improved at much faster rates than in other developing countries. In seven of the countries, per capita calorie consumption also rose at least 1 percent per year during 1961-76. In Mexico and Paraguay where it rose less than 1 percent, the growth in per capita calorie consumption equalled or exceeded that of per capita food production. In contrast, little improvement occurred in the dietary energy consumption in other DME countries outside the rapid-growth group.

The rapidly increasing demand for livestock and poultry feed in several rapid-growth DMEs greatly stimulated staple food production, especially in the Latin American countries and in the high-income countries in the North Africa/Middle East region. Increases in food consumption and production appeared to have mutually reinforced each other in several of these countries. Rising income has led to increased consumption of livestock and poultry products, which has in turn stimulated increases in the output of maize, sorghum, and cassava for livestock feed, i.e., for conversion into these higher-quality foods.

It appears that the traditional net exporters to DMEs need not worry about losing their markets as the result of an expansion of food production in the rapid-growth countries. Although the proportion of consumption coming from domestic production in these countries increased, the volume of their net imports of staple food also increased (the net increase in imports was even stronger among the slower growing DMEs). Net staple food imports per year in these countries rose 2 1/3 times between 1961-65 and 1974-76; actual imports levels grew by 87 percent while exports increased by 53 percent. The expansion of both exports and imports reflects on one hand the increased production capacity for particular crops in these countries, and on the other, the rapidly increasing demand for food staples generated by population growth and improved income levels. The absolute and relative changes in the average yearly trade levels for staple foods between 1961-65 and 1974-76 were:

| | (1,000 metric tons) | (percent) |
|---|---|---|
| Imports | +6,510 | +86.5 |
| Exports | +2,337 | +53.2 |
| Net Imports | +4,173 | +133.0 |

The fast growth of food production in the study countries resulted from significant increases in a wide variety of staple food crops. Maize contributed 28 percent, wheat 24 percent, and rice 19 percent to the total increase in food output; sorghum contributed 10 percent, and the share of the rest of the cereals was 3 percent. Increases in root crop output, primarily cassava, accounted for 10 percent of the total increment in staple food crop production. (In the slow-growth and other DME countries, wheat and rice contributed nearly two-thirds of the increase in staple food production, with maize contributing less than 15 percent.)

Wheat and sorghum production increased in importance in the rapid-growth countries in the 1961-76 period, whereas maize maintained its relative importance. Although rice has made a large contribution to the growth of food output in these countries, its relative share of total production has declined slightly. Changes in commodity demands have been important in these shifts of production growth patterns. The shares of the important cereal crops in total food output of the 16 countries in 1961-65 and 1974-76 were:

|  | 1961-65 | 1974-76 |
|---|---|---|
|  | (percent) |  |
| Maize | 29 | 29 |
| Rice | 24 | 22 |
| Wheat | 15 | 19 |
| Sorghum | 3 | 6 |
| All Cereals | 77 | 80 |

Maize accounted for more than half of food production growth in Brazil, El Salvador, and Paraguay, whereas wheat was the dominant contributor to food output in Iran, Pakistan, and Tunisia. Rice, the most important food staple in Asia, contributed 88 percent of the increase in Malaysia and 50 percent in the Philippines. Sorghum accounted for nearly half the increase in Mexico and, together with groundnuts, represented the dominant source of increased production in the Sudan. Barley represented 53 percent of the food increase in Morocco. In the Ivory Coast, root crops contributed more than half of the growth of staple food output.

## Sources of Growth

Rapid growth in food production falls into three patterns based on the relative contributions of area expansion and increased output per hectare. The latter was the dominant factor in Colombia, El Salvador, Mexico, Morocco, Pakistan, and Tunisia, contributing from 63 percent to 93 percent of production growth. In the Ivory Coast, Malaysia, the Philippines, and Thailand, the contributions of the two factors were nearly equal. Area expansion contributed 72 percent or more of the growth of food output in Brazil, Chana, Iran, Paraguay, Sri Lanka, and the Sudan. And increases in crop area entirely sustained the rapid growth of staple food production in Ghana, Paraguay, and the Sudan, where declines in output per hectare occurred.

Shifts in crop area patterns toward higher- or lower-yielding crops (in tonnage per hectare) significantly affected the total output per hectare of staple food crops in several of the study countries. Except for the Sudan, all data for selected rapid-growth countries reflected increases in output per hectare when the effects of changes in crop area pattern are excluded. Relatively more rapid expansion in the area of sorghum in Mexico, sorghum and root crops in Colombia, and root crops and maize in Thailand has increased the average annual rate of growth in output per hectare by around 1 percent a year. In Pakistan, the faster expansion of rice area relative to wheat area contributed 0.5 percent to the growth in output per hectare. In the rapid-growth countries where increases in food output came largely from rapid area expansion, however, significant shifts from relatively high-yielding root crops into cereals reduced the annual growth rate

TABLE 1

Average annual growth rates of production, area, and output per hectare of total staple food crops in selected rapid-growth countries classified according to main sources of growth, 1961-76 [a]

| Country by Category | Production | Area | Output Per Hectare |
|---|---|---|---|
| | | (percent) | |
| Largely increased output per hectare | | | |
| Colombia | 3.8 | 0.7 | 3.1 |
| El Salvador | 5.7 | 2.1 | 3.6 |
| Mexico | 3.8 | 0.8 | 3.0 |
| Morocco | 3.7 | 0.6 | 3.1 |
| Pakistan | 4.7 | 1.0 | 3.7 |
| Tunisia | 5.7 | 0.4 | 5.3 |
| Increased area and output per hectare | | | |
| Ivory Coast | 3.4 | 1.9 | 1.5 |
| Malaysia | 4.9 | 2.9 | 2.0 |
| Philippines | 3.9 | 1.8 | 2.1 |
| Thailand | 4.2 | 2.2 | 2.0 |
| Largely increased area | | | |
| Brazil | 3.5 | 3.4 | 0.1 |
| Ghana | 3.5 | 3.7 | −0.2 |
| Iran | 4.3 | 3.1 | 1.2 |
| Paraguay | 3.6 | 5.3 | −1.7 |
| Sri Lanka | 3.7 | 3.4 | 0.3 |
| Sudan | 4.4 | 5.8 | −1.4 |
| Selected rapid-growth | 3.9 | 2.2 | 1.7 |
| Other DMEs | 2.2 | 0.7 | 1.5 |
| Selected slow-growth | 1.1 | 0.8 | 0.3 |
| All DMEs | 2.6 | 1.1 | 1.5 |

Sources: Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1975," Rome, 1975; and Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1976," Rome, 1976.

[a] Excluding plantains.

of output per hectare of staple food crops. Changes in the crop area pattern of staple food crops did not seem to affect the output per hectare in Morocco, the Ivory Coast, and the Sudan.

## TABLE 2

Average annual growth rates of production, area, and output per hectare of cereal crops in selected rapid-growth countries classified according to main sources of growth, 1961-76 a/

| Country by Category | Wheat |  |  | Rice |  |  | Maize |  |  | Sorghum |  |  | Total Cereals c/ |  |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  | Production | Area | Output Per Hectare | Production | Area | Output Per Hectare | Production | Area | Output Per Hectare | Production | Area | Output Per Hectare | Production | Area | Output Per Hectare |
|  |  |  |  |  |  |  | (percent) |  |  |  |  |  |  |  |  |
| Largely increased output per hectare |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Colombia | −7.3 | −10.4 | 2.9 | 7.7 | 1.2 | 6.5 | −0.2 | −1.9 | 1.7 | 27.1 | 26.5 | 0.6 | 2.6 | 0.3 | 2.9 |
| El Salvador | ... | ... | ... | 4.5 | 0.7 | 3.8 | 6.0 | 1.5 | 4.5 | 4.8 | 2.4 | 2.4 | 5.6 | 1.6 | 3.8 |
| Mexico | 4.3 | −0.6 | 4.9 | 3.2 | 1.4 | 1.8 | 1.7 | 0.0 | 1.7 | 17.5 | 16.0 | 1.5 | 3.9 | 1.0 | 2.9 |
| Morocco | 2.8 | 0.5 | 2.3 | ... | ... | ... | 0.9 | −0.9 | 1.8 | ... | ... | ... | 3.1 d/ | 0.4 d/ | 2.9 d/ |
| Pakistan | 5.8 | 1.7 | 4.1 | 6.6 | 2.1 | 4.5 | 3.3 | 2.1 | 1.1 | 1.6 | −0.3 | 1.9 | 3.2 | 1.3 | 3.9 |
| Tunisia | 5.9 | 1.2 | 4.7 | ... | ... | ... | ... | ... | ... | ... | ... | ... | 5.5 | 0.3 | 5.3 |
| Increased area and output per hectare |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Ivory Coast | ... | ... | ... | 5.5 | 2.4 | 3.1 | 1.1 | 3.7 | −2.6 | 6.8 | 5.0 | 1.8 | 3.6 | 2.1 | 1.5 |
| Malaysia | ... | ... | ... | 5.0 | 3.1 | 1.9 | 7.0 | 0.5 | 6.5 | ... | ... | ... | 5.0 | 3.1 | 1.9 |
| Philippines | ... | ... | ... | 3.4 | 0.8 | 2.6 | 5.5 | 3.4 | 2.1 | ... | ... | ... | 4.1 | 1.9 | 2.2 |
| Thailand | ... | ... | ... | 2.1 | 1.0 | 1.1 | 10.2 | 9.1 | 1.1 | 13.9 b/ | 17.0 b/ | −1.1 b/ | 3.4 | 1.8 | 1.6 |
| Largely increased area |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Brazil | 12.4 | 10.8 | 1.6 | 2.2 | 3.0 | −0.8 | 4.2 | 2.8 | 1.4 | 17.3 | 7.9 | 9.4 | 4.4 | 3.7 | 0.7 |
| Ghana | ... | ... | ... | 6.1 | 7.3 | −1.2 | 5.7 | 4.8 | 0.9 | 2.8 | 2.4 | 0.4 | 4.9 | 4.6 | 0.3 |
| Iran | 4.8 | 3.4 | 1.4 | 4.4 | 2.7 | 1.7 | ... | ... | ... | ... | ... | ... | 4.4 | 3.2 | 1.2 |
| Paraguay | 9.8 | 11.9 | −2.1 | 9.0 | 10.7 | −1.7 | 6.4 | 6.5 | −0.1 | ... | ... | ... | 6.8 | 7.2 | −0.4 |
| Sri Lanka | ... | ... | ... | 2.8 | 1.9 | 0.9 | 7.9 | 8.4 | −0.5 | ... | ... | ... | 2.9 | 2.1 | 0.8 |
| Sudan | 16.2 | 18.4 | −2.2 | ... | ... | ... | 7.7 | 6.6 | 1.1 | 2.9 | 1.2 | −1.3 | 3.6 | 5.5 | −1.9 |
| Selected rapid-growth | 5.5 | 2.8 | 2.7 | 3.1 | 1.7 | 1.4 | 3.7 | 2.0 | 1.7 | 9.0 | 5.4 | 3.6 | 4.1 | 2.3 | 1.8 |
| Other DMEs | 4.2 | 1.7 | 2.5 | 2.5 | 0.9 | 1.6 | 2.4 | 1.2 | 1.2 | 1.9 | 0.1 | 1.8 | 2.5 | 0.8 | 1.7 |
| Selected slow-growth | 1.9 | 0.7 | 1.2 | 1.5 | 1.0 | 0.5 | 1.4 | 1.0 | 0.4 | 0.0 | 0.8 | −0.8 | 1.1 | 0.7 | 0.4 |
| All DMEs | 4.5 | 2.0 | 2.5 | 2.6 | 1.1 | 1.5 | 3.0 | 1.6 | 1.4 | 3.0 | 0.7 | 2.3 | 2.9 | 1.1 | 1.8 |

Source: Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1975," Rome, 1975; and Food and Agriculture Organization of the United Nations, "Production Yearbook Tape, 1976," Rome, 1976.

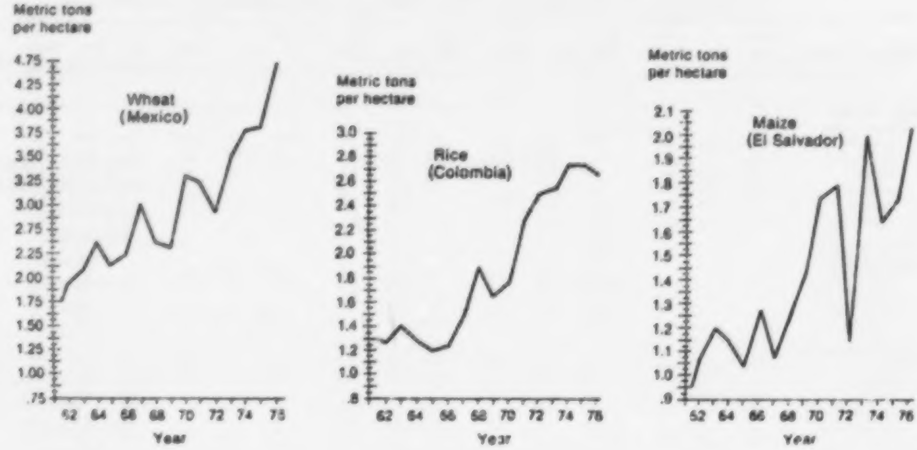
a/ Includes crops in countries where the 1976 production was more than 1 percent of total major staple food production.
b/ For the period 1964-76.
c/ Includes all cereals
d/ In Morocco, the growth rates of production, area, and output per hectare of barley were 4.6, 0.8, and 3.8 respectively.

Changes in production inputs. The extent to which assessments can be made of the influence of increased use of agricultural production inputs on the growth in output per hectare and area of staple food crops is limited by the lack of data on the use of these inputs by crop. Available international data on fertilizer use, irrigation, agricultural employment, and tractor use are in totals for agriculture as a whole. The significance of increases in tractor numbers also varies because of the large variations in the size of tractors used in the various countries. Nevertheless, analysis of the increases in the use of agricultural production inputs can provide some important additional indications of how the rapid-growth countries achieved the increases in crop yields and overall output per hectare.

Table 3 compares the increases between 1961-65 and 1975 in fertilizer consumption per hectare of gross cropped area, and the percentage of arable land under irrigation, with the changes in both

FIGURE 1

YIELDS OF WHEAT, RICE, AND MAIZE IN LEADING COUNTRIES, 1961-76



the trend and the "hypothetical" output per hectare of food crops with cropping patterns unchanged. In addition, the results of a regression predicting increases in the hypothetical output per hectare resulting from given changes in fertilizer use and irrigation are shown in the last column. The effects of a shift to more extensive or intensive staple food crops are seen in a comparison of column 3 with column 4, and were considerable in some countries--notably Paraguay, Ghana, Colombia, Thailand and Mexico.

Although overall increases in fertilizer use and irrigation were closely associated with yield increases of staple food crops in many countries, the association was poor in some cases. In Tunisia, Brazil, and the Sudan other factors appear to obscure the changes in fertilizer use and irrigation that are associated with variations in the hypothetical output per hectare. If these countries are omitted, changes in these two factors would account for 82 percent of the changes in the hypothetical output per hectare (columns 4 and 5).

Other factors, specifically high-yielding varieties and, to a lesser extent, mechanization have also been very important in particular countries. Information on the use of high-yielding varieties of wheat and rice are shown in Table 4. Increases in staple food crop area in the rapid-growth countries were also associated with increases

# TABLE 3

## CHANGES IN FERTILIZER USE PER HECTARE, IRRIGATED AREA, AND OUTPUT PER HECTARE OF STAPLE FOOD CROPS IN THE SELECTED RAPID-GROWTH COUNTRIES, 1961-65 to 1974-76[a]

| Country | Fertilizer Use Per Hectare of Total Crop Area (kilograms) | Portion of Arable Land Under Irrigation (percent) | Staple Food Output per Hectare (kilograms) | | |
|---|---|---|---|---|---|
| | | | Actual[c] | Hypothetical[d] | Regression Estimate[e] |
| | (1) | (2) | (3) | (4) | (5) |
| Largely increased output per hectare | | | | | |
| Colombia | 27.4 | 1.2 | 515 | 349 | 241 |
| El Salvador | 81.5 | 3.1 | 516 | 559 | 569 |
| Mexico | 43.4 | 1.3 | 427 | 313 | 334 |
| Morocco | 18.1 | 3.1 | 291 | 291 | 206 |
| Pakistan | 25.2 | 11.3 | 397 | 343 | 325 |
| Tunisia | 9.0 | 1.6 | 328 | 316 | - |
| Increased area and output per hectare | | | | | |
| Ivory Coast | 9.3 | 1.3[b] | 148 | 148 | 138 |
| Malaysia | 40.6 | 2.0 | 357 | 375 | 324 |
| Philippines | 12.7 | 6.8 | 203 | 222 | 227 |
| Thailand | 10.7 | 6.0 | 305 | 152 | 191 |
| Largely increased area | | | | | |
| Brazil | 30.9 | 0.9 | 14 | 56 | - |
| Ghana | 4.1 | 0.6 | -33 | 50 | 102 |
| Iran | 33.6 | 1.6 | 128 | 139 | 280 |
| Paraguay | -0.1 | 2.4 | -355 | 63 | 95 |
| Sri Lanka | 1.7 | -1.7 | 56 | 93 | 66 |
| Sudan | .3.9 | 4.6 | -120 | -120 | - |
| Selected rapid-growth | 24.6 | 3.0 | 215 | - | - |
| Other DMEs | 13.2 | 1.7 | 160 | - | - |
| Selected slow-growth | 5.8 | 1.5 | 29 | - | - |
| All DMEs | 16.4 | 2.0 | 177 | - | - |

Sources: Food and Agriculture Organization of the United Nations, (FAO) "Production Yearbook Tapes," for 1975 and 1976; and *FAO 1976 Annual Fertilizer Review*.

[a] Based on the following data: Fertilizers, 1961/62-1965/66 and 1973/74-1975/76; arable land and irrigation, 1961 - 1965 average and 1975; output per hectare, trend estimates for 1964 and 1975.

[b] Based on area of temporary crops only.

[c] Based on the trend estimates for area and production.

[d] Hypothetical increases in output per hectare that would have occurred if cropping patterns had been unchanged but yields of each crop were those experienced.

[e] Changes in output estimated from the following regression based on 13 countries (omitting Tunisia, Brazil, Sudan) $\Delta Q = 7235 + 5.734\Delta N + 9.538\Delta I$; $R^2 = 0.82$; where $Q$ = output per hectare of staple food, $N$ = fertilizer per hectare, $I$ = percentage of arable land under irrigation.

## TABLE 4

### Percentages of wheat and rice areas with high-yielding varieties, 1976/77; and cropping indexes, 1961-65 and 1975

| | | | Cropping Index[c] | |
|---|---|---|---|---|
| Country | Wheat | Rice | 1961-65 | 1975 |
| | (percent) | | | |
| Brazil | - | - | 104 | 132 |
| El Salvador | - | - | 90 | 115 |
| Colombia | - | 69 | - | - |
| Iran | 3[a] | - | - | - |
| Malaysia (West) | - | 37[a] | 93 | 103 |
| Mexico | 89 | 79 | - | - |
| Pakistan | 75 | 40 | 112 | 116 |
| Philippines | - | 68 | 122 | 151 |
| Sri Lanka | - | 63[a] | 96 | 128 |
| Sudan | 50 | - | - | - |
| Thailand | - | 11 | - | - |
| Tunisia | 22[b] | - | - | - |

Source: Area percentages based on Dana G. Dalrymple, *Development and Spread of High-Yielding Varieties of Wheat and Rice in the Less Developed Nations*, Foreign Agricultural Economic Report No. 95 (Washington, D.C.: U.S. Department of Agriculture, September 1978).

Crop index from FAO "Production Yearbook Tape," 1975.

[a] 1975/76.
[b] Includes locally improved dwarf durum varieties.
[c] Ratio of cropped land to arable land (values above 100 indicated multiple crops on the same lands in one year).

in multiple cropping as measured by the ratio of cropland to arable land (see the cropping index included in Table 4.) This factor was of considerable importance in several of the Asian countries, where the introduction of early-maturing, high-yielding varieties, particularly in irrigated areas, greatly enhanced the opportunities for multiple cropping. Cropping intensities also increased in some of the Latin American countries.

The area of staple food crops expanded substantially faster than the total crop area in four of the rapid-growth countries, especially in Ghana and Sri Lanka. In Brazil, Iran, Paraguay, and the Sudan, a rapid expansion in the land used for all crops occurred. While the agricultural labor force has increased in 14 of the 16 countries, the rate of growth in staple food crop area exceeded the growth of labor force in most of them. The wider use of multiple cropping and the increased emphasis on staple food crops appeared to be associated with the increased crop area per agricultural worker in several of the countries. Mechanization was a significant factor in area expansion in some countries. Changes in tractor numbers were used to provide some indication of the progress in mechanization (Table 5).

TABLE 5

Changes in tractor numbers in the rapid-growth countries, 1961-65 to 1975

| Country by Category | Number of Tractors Per 1,000 Hectares of Total Crop Area 1961-65 | 1975 | Average Annual Rate of Growth in Tractor Numbers, 1961-65 to 1975 |
|---|---|---|---|
| | | | (percent) |
| Largely increased output per hectare | | | |
| Colombia | 6.5 | 7.0 | 2.2 |
| El Salvador | 3.0 | 4.0 | 4.1 |
| Mexico | 5.2 | 9.5 | 5.7 |
| Morocco | 1.5 | 3.5 | 7.9 |
| Pakistan | 0.5 | 2.6 | 15.9 |
| Tunisia | 4.1 | 9.9 | 7.8 |
| Increased area and output per hectare | | | |
| Ivory Coast | 0.2 | 0.9 | 15.7 |
| Malaysia | 0.7 | 1.9 | 10.8 |
| Philippines | 0.6 | 0.6 | 2.3 |
| Thailand | 0.3 | 1.5 | 18.5 |
| Largely increased area | | | |
| Brazil | 3.0 | 5.5 | 8.8 |
| Ghana | 0.6 | 1.0 | 5.2 |
| Iran | 1.8 | 3.2 | 8.2 |
| Paraguay | 2.9 | 2.7 | 5.0 |
| Sri Lanka | 3.7 | 7.1 | 8.0 |
| Sudan | 0.6 | 1.4 | 13.0 |
| Selected rapid-growth | 2.3 | 4.3 | 7.7 |
| Other DMEs | 1.3 | 2.9 | 7.6 |
| Selected slow-growth | 0.8 | 1.6 | 7.0 |
| All DMEs | 1.6 | 3.3 | 7.7 |

Sources: Food and Agriculture Organization of the United Nations, "Production Yearbook Tapes," for 1975 and 1976.

## Overview of Changes in Individual Countries

The wide variation in resource and technological changes among the 16 DME countries showing the largest sustained food production growth since 1961 suggests that a diversity of approaches is required to achieve major increase in food production in developing countries. The experiences of the rapid-growth countries clearly indicate that no single factor or small group of factors can be specifically prescribed to attain rapid growth in food production. In several of the rapid-growth countries, large increases in staple food crop production appear to be associated with the shifts in demand for better quality foods. Growth in demand for livestock products, particularly in the middle- and high-income countries, greatly stimulated the production of staple food crops that are utilized for livestock feed, such as maize, sorghum, and in some countries, cassava. In others such as Ghana, the Ivory Coast, and Malaysia, the changes in the production patterns for staple food crops reflect more emphasis on cereals and less on root crops. Export demand appears to have stimulated the rapid growth of maize and cassava output in Thailand, and of groundnut production in the Sudan.

The wide range of the commodity sources of growth raises questions as to the need for intensifying local and international research and development efforts in developing countries to give emphasis to a wider variety of crops. While the well-known increases in rice and wheat production were important, more than half the increase in food output in the rapid-growth countries came from other crops less favored in research funding. The role of area expansion in increasing production in these countries has been much larger than is often suggested. Although policies emphasizing area expansion appear needed in some other developing countries, the study findings also suggest that such approaches must vary with the physical and economic conditions, and that problems of soil management may be increasing in some of the countries.

[Extracted from Chapters 1, 4 and 5 of Rapid Food Production Growth in Selected Developing Countries: A Comparative Analysis of Underlying Trends. Research Report No. 11 of the International Food Policy Research Institute (IFPRI), Washington, D.C., October 1979. Copyright © IFPRI.]

# Food Policy in China

C. Peter Timmer

[The methods used in China to assure supplies of basic foodstuffs for its very large population are of considerable interest. Mobilizing large amounts of manpower for building infrastructure, freeing farm labor for this by selective mechanization, pragmatic planning, and especially the reliance on economic incentives for small groups are among the important policies.]

That China has solved its food problem is the universal story brought back by medical, agricultural, and other scientific observers who have recently toured China. It is a claim made by the Chinese themselves. How could the world's oldest, largest, and in many respects most impoverished nation accomplish such a feat when the food prospects for many of the rest of the world's poor nations seem increasingly bleak? The U.S. National Academy of Sciences delegation that toured China in the summer of 1975 attempted to answer this question while observing small-scale rural industry and its interaction with agricultural growth. From the beginning it was clear that small-scale rural industry was not a goal in itself but was intended as a vehicle for imparting vitality into the countryside.

The solution to China's food problem involves two fundamental and connected components--increasing food supplies through agricultural growth, and ensuring access to those food supplies by means of socialist distribution mechanisms. Small-scale rural industry as one major component of China's food policy was observed directly; our observations, questions, and briefings provided information on the other. A substantial technical and scholarly literature exists on

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the details known to the outside world of China's agricultural development program. This article is not a review of that literature but rather is a broad sketch of the strategies used by the Chinese in their development effort, and of the mechanisms used to ensure that the entire population has access to the fruits of that effort. While it is convenient to treat these two topics separately, the Chinese emphasize that the social mechanisms of access and distribution are an integral component of the production system itself.

## Increasing Food Supplies

Before the People's Republic consolidated its victory in 1949, China was among the most wretched of countries. The overwhelming misery and human suffering that existed are still vivid memories for the survivors, who tell and retell their stories to the younger generation which has not lived under the "triple yokes of feudalism, imperialism, and bureaucratic capitalism." The contrast between the peasant's life then and now is constantly invoked as motivation for and justification of the enormous physical effort and ostensible loss of personal freedom involved in the transformation of Chinese agriculture. The process of that transformation as it is described here does not depict the historical evolution of any single commune or region, but represents a purposeful abstraction of the development of Chinese agriculture. It is, in some sense, a model of Chinese agricultural development as the Chinese would like the visitor to understand it. Its purpose is to help us understand Chinese agricultural policy--to understand what the Chinese leadership wants to happen. Since the Chinese have adequately demonstrated a real capacity for implementing policies, this understanding is an important ingredient in evaluating China's success. How fast the basic model is diffusing across the Chinese countryside is a question answered only by time and the Chinese themselves.

Pre-Liberation Chinese agriculture was trapped in a low level equilibrium, with farm productivity balanced by the resources available and the incentives and organizational structures for change. Given the devastation of the economy during the Second World War and subsequent civil strife, some increase in food production would have been forthcoming under a private economy. But major progress was unlikely without substantial restructuring of land ownership and of the organizational mode of farming. These changes came sequentially with the land reform of the early 1950s, the primitive co-ops of the mid-1950s, and the final culmination of the Rural People's Communes in 1958. The organizational structures then existed that were capable of mobilizing vast quantities of surplus labor for large-scale projects, primarily involved in restructuring farmland and in carrying out major water control works; transportation facilities also absorbed much labor.

Some of the labor needed for such vast undertakings had been available in the slack seasons for many years. But much more was needed to attack and transform nature on the grand scale widely advertized by the Chinese and now attested to by a variety of uniformly impressed foreign visitors. This seemingly paradoxical need to generate more surplus labor provides the rationale for the first stage of agricultural mechanization--processing basic food gains by machines instead of by hand. Such mechanization became possible only when rural electricity began to be available, and the labor savings were truly enormous. According to a local Chinese spokesman, in 200 days of operation a commune-run rice mill of three tons per hour capacity saves about 2 million man-hours of labor. This saved labor is mostly female, but the argument is not weakened. Women work side by side with men in the water conservancy and farmland capital construction projects. A very substantial proportion of the total labor input in such projects involves moving soil and stone with baskets on shoulder poles. Women and men both engage in this task.

Two other important roles existed for the newly generated surplus labor. Cement is a critical ingredient in a wide variety of rural industrial and agricultural projects, and its production in small-scale rural plants is a unique feature of the Chinese model. These plants transform locally quarried limestone and coal into low- and medium-quality cement which is suitable for lining aquaducts and for mortaring bridges and terrace-retaining walls. The process from coal mine and quarry to production and use is enormously labor intensive and could not be conducted at its present magnitude without the workers freed by the first stages of agricultural mechanization.

The third role for surplus labor is to increase the amount of organic manure prepared and distributed to the fields. The new awareness of the finite supply of fossil fuels has prompted a number of recommendations in the West that energy-intensive agricultures should reduce chemical fertilizer applications in favor of organic manures. There seems to be little understanding, however, of the extent to which organic manure is merely congealed human labor. Organic manure has always been the mainstay of Chinese agriculture, but it was never applied in the past in the prodigious quantities now being used in the model areas because vast quantities of communally organized labor are required. Thus the generation of surplus labor within the commune permitted a substantial increase in the production and application of this vital yield-sustaining-and-raising input into Chinese food production. As an example of the enormous quantities of organic manure being used in some areas, our delegation visited communes applying over 200,000 kilograms of organic compost per hectare. Even conservative estimates of nutrient content indicate a nitrogen application of over 500 kilograms per hectare, which is high by any standard.

As the productivity potential of farmland was raised through leveling and terracing, and the risks from drought and floods were attenuated by irrigation and drainage works, opportunities emerged for extension of double cropping. Double-cropped rice land in the South has been common for centuries, but extension of the system northward and to other crops meant rapidly performing the harvest of the early crop and all the preparations for the second. These tasks are highly labor intensive with traditional techniques, and existing labor was already fully employed. The bottleneck was broken by the introduction of mechanical threshers, technically the easiest area of mechanization. Indeed, pedal operated, semi-mechanized threshers had been a fairly standard feature in double-cropped rice fields since the 1950s. But wheat threshing is technically more difficult because more power is required. Widespread mechanical wheat threshing awaited widespread rural electrification so that motor driven threshers on central threshing floors could be used.

Rural electrification has had an enormous impact on agricultural mechanization, and hence on generation of the labor surplus needed to "drive" the model, for two distinct reasons. First, the availability of electricity at the commune and brigade level has fostered an extensive network of agricultural machinery repair and manufacturing shops. All of the shops we visited had lathes, grinders, and milling machines. Many, especially at the commune level, are engaged in relatively large-scale manufacture of threshers, pumps, tractors, and similar items which would be impossible without electricity. Rural electrification, then, has permitted the diffusion of manufacturing and repair capability well into the countryside, with obvious advantages in terms of local access to agricultural machinery and its repair and the suitability of the machinery to local conditions.

Second, electric motors are the prime movers for a surprisingly large range of agricultural machinery. Most western agricultural machinery is designed to take the mechanical process to the field and to return with what is directly consumable. The Chinese view agriculture in a broader, more ecologically sound perspective. They bring more of the land's output to a central place--although ultimately more is returned to the land after composting and fermentation into organic manure. If the central place has electricity, a great many functions can be electrically powered that would otherwise be done by hand in the field before mechanization, or with gasoline or diesel engines afterward. Threshing tends to be one of the first field tasks mechanized, usually by an electrically powered thresher on a central threshing floor, often in conjunction with an electric fan to assist in winnowing. The low standards of construction and maintenance required for electric motors relative to petrol engines thus make many mechanization tasks cheaper and technically simpler, and hence more readily adopted in the countryside.

With increased potential for multiple cropping two other inputs become critical to further production gains: short-season, high-yielding, fertilizer-responsive grain varieties, and the chemical fertilizer to put on them. The evidence is now clear that the Chinese developed and widely distributed short-stature, high yielding rice and wheat varieties somewhat before similar advances were made by the international research institutes, especially the International Rice Research Institute (IRRI) and the International Center for the Improvement of Maize and Wheat (CIMMYT). The Chinese rice varieties did not have quite the yield potential of the early IRRI varieties but did have a significantly shorter growing season, which was essential to double cropping.

Although double cropping is not doubly exhausting to the soil relative to single cropping because yields usually do not double, substantially more nutrients are required on a long-term basis. These added nutrients are very difficult to provide strictly from organic manures, and so chemical fertilizers suddenly had a very high productivity if they could be gotten to the fields. In this context the small-scale rural fertilizer factories for which China is famous make excellent economic sense despite their apparent high costs in raw materials per nutrient ton. The factories use coal as the primary raw material to produce reduced hydrogen and then ammonia via the standard Haber process. The unusual aspect of the Chinese process is the end product derived from the gaseous ammonia. Instead of using technically sophisticated (and very expensive) compressors to convert the ammonia gas directly to anhydrous ammonia and possibly then to urea, as in modern plants, the Chinese rural factories compress the gas only enough to react it with other inexpensive agents to form ammonium nitrate (35 percent nitrogen) or ammonium bicarbonate (17.5 percent nitrogen). The first compound is a well known fertilizer and also an explosive when pure. The ammonium nitrate from Chinese factories is used for both purposes. The second compound is much lower in nutrient content and is little known outside China.

The capital costs of the rural fertilizer factories are substantial, even when much of the material and labor for construction is local and of low opportunity cost. The ammonium nitrate factory in Da Zhai, for example, required 33 tons of stainless steel, which is available only by allocation from the State. The banks of reciprocal compressors needed in either type of plant are made only in State factories. Thus the widespread appearance of these small-scale rural fertilizer factories was a clear signal of the timely understanding at the national policy level of the necessity to invest heavily in the food production sector if output was to be increased. But the operating costs of the small fertilizer factories are borne locally. These costs are mostly labor and raw materials, primarily coal, which is actually labor just one stage removed if a local coal deposit exists. So once again, the necessity to create surplus labor is clear. Mechanization of threshing and processing seems to have been the most economical source of this surplus.

With these transformations the basic ingredients of high-yielding agriculture--water control, fertilizer, responsive seeds, and adequate labor for careful cultivation--were in place. The addition of high capacity pump sets to the hand-dug water control network permitted the high potential yields to become high and stable yields, which was the first priority of food production policy. The efficacy of the policy and the implementation was demonstrated from 1972 through 1974 when droughts struck much of northern China. It was a major achievement that Chinese food production did not drop significantly during this period.

## Mechanization

Chairman Mao pointed out that "mechanization is the only way out for agriculture." Present plans call for the basic mechanization of Chinese agriculture by the early 1980s. In retrospect the mechanization of food processing, threshing, and some land preparation served as the catalyst to speed the labor-driven model for increasing and guaranteeing food supplies. For the future, widespread mechanization of land preparation, transplanting and harvesting will continue to free large volumes of labor, but except for some marginal increases in multiple cropping the yield gains will be small. In addition, mechanizing these tasks faces major technical difficulties.

Two important factors explain why land preparation is only beginning to show substantial progress in mechanization. The first is the level of technology required on a broad front to mechanize land preparation. The essential input is the tractor, either two-wheeled or four-wheeled. The tractor requires sophisticated engine making and repairing capacity as well as petroleum products available in the countryside. The second factor is that mechanizing land preparation leaves only a marginal role for draft animals in direct agricultural production. Since these animals play a substantial role in the generation of organic fertilizer, removing them from the farm scene in China is rather more complicated than it was in the United States where only their horsepower was replaced.

Mechanization of land preparation is further complicated by the pressing need for transportation vehicles in rural China. Large quantities of materials are still moved by shoulder poles, human-drawn carts, and animal-drawn vehicles of all descriptions. The temptation is enormous to substitute tractors for human transport labor. Since plowing with animals is easier work than transporting materials long distances by hand, most tractors in the countryside seem to be on the road and not in the field. Many animals were seen by the delegation preparing the land for second crops; a much higher proportion of the winter and spring deep plowing may be done by machine. Nevertheless, it is not surprising that a production unit might decide to use its animals for plowing at low opportunity cost and use its tractors primarily on the road. This suggests that full mechanization of land preparation will only be attained simultaneously with the rural capacity to build small, locally adapted trucks. Only at this stage will it be possible to get rid of draft animals, thereby raising the opportunity cost of animal plowing.

Mechanical transplanting is still in its infancy, even in the model areas. Research and development in this area are being pushed vigorously as a further means of flattening seasonal labor demand peaks and speeding the turnaround time between growing crops in the field. Success in this effort will also make a major contribution to one other goal high on the list of priorities of Chinese leaders--to reduce the drudgery of agricultural labor. The Chinese do not shun hard physical work. Nearly everyone, including government bureaucrats and university professors, is expected to engage in some manual labor each year, preferably on farms. But the goal of policy is to reduce the gap between the physical effort involved in field work versus that in the factory. By narrowing this gap as well as the income differential between rural and urban areas, the Chinese feel they can dampen the presently strong preferences of rural workers to try to obtain factory jobs in cities. By reducing rural pressures to migrate to the cities, pressures thwarted at the moment by effective bureaucratic controls over access to urban food supplies (as well as other measures), the subsequent social overhead capital investment required to house and service adequately a large flow of rural migrants will be similarly reduced. The intent is to keep peasants on the farm by making rural work as attractive as possible.

The last stage of Chinese agriculture to be mechanized will probably be harvesting. The mechanical revolution in European and American agriculture began with harvesting; and similar large, uniform tracts of grain in the northeast of China are reported to be similarly mechanized. But mechanically harvesting small plots of intercropped grains is a different task. Small reapers mounted on walking tractors have been successfully demonstrated, but their use is not widespread. Small combines for wheat, which may be interplanted with corn (a popular new practice that raises the multiple-cropping index), may be feasible, but their development is in the design stage only. The Chinese custom is to remove all the straw from the field for fodder and composting; thus combines lose much of their potential advantage over simpler reapers. By either means great volumes of material must be carried out of the field, a task likely to be done by hand in the foreseeable future. Development of

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suitable machines will no doubt be pushed, however. Like the transplanter, mechanical harvesters are justified for their contribution both to speeding the interchange of crops and to reducing the physical effort required of agricultural workers.

Speeding agricultural work by substituting machines for human labor raises the fairly immediate possibility of the kind of technological unemployment witnessed in a number of Asian rural areas. Eventually, and perhaps within a decade, a substantial proportion of China's rural population will not be needed in the fields. The Chinese are unconcerned about this eventuality. The reasons have to do partly with the distribution mechanisms discussed in the next section. If mechanization does not cause output to fall, then total agricultural income will remain the same and be communally shared. Such technological unemployment might better be termed leisure, which is as valued in China as elsewhere. But more important in Chinese plans is the continued potential to create productive new jobs for the labor saved in agriculture. Significant diversification away from crop raising and toward animal husbandry, fruit raising, beekeeping, food and fiber processing, and small-scale rural industries is already apparent even at the brigade level in some model areas. The share of these sideline occupations is expected to rise sharply as fewer workers are needed directly on the land. This transfer of workers from farm to factory is a feature of the development of all wealthy societies. The Chinese model is unique in that the transfer in this early stage involves shifts in occupation but not changes in location.

## Incentives and Access to Food Supplies

Except for the unique aspect of employing the surplus agricultural labor in rural factories rather than in urban ones, the physical schema the Chinese are using to increase food production is entirely consistent with the classical surplus labor model of economic development outlined over two decades ago by W. Arthur Lewis. Implementation of the model is the critical issue. Any country could (and some did) place similar schemes on paper in ten- and twenty-year perspective plans. The Chinese are succeeding in transforming the plan into reality. If other poor countries are to learn any lessons for their own food policies from the Chinese experience, they must not stop with the physical model, although it is very important, but must also understand what the Chinese regard as twin complements to the physical model: the organizational and personal incentives needed to push the model from paper to field, and the social and bureaucratic mechanisms that distribute the resulting output.

Certain inevitable tensions exist between incentive and distributional policies in a society bent on guaranteeing minimal living standards to all citizens while raising those standards on the average. China has not escaped those tensions, but it has attempted to balance them in a pragmatic fashion evolved from the results and lessons of many experiments. Many in the West view Chinese society, or at least the commune, as noble confirmation that individuals can join in an effort directed toward the general good without concern for individual reward beyond the shared public welfare. They think the guiding principle of Chinese distributional policy is the traditional Marxist formulation--"from each according to his ability, to each according to his need." The Chinese emphasize, however, that the reality is considerably more complex. The present formulation of the distributional rule in all but a very few circumstances is "from each according to his ability, to each according to his work." This rather Calvinistic expression demonstrates that at the heart of both Chinese distributional *and* incentive policies are individual material rewards for the human labor that drives the physical production model.

Wages in factories and offices are typically based on an eight grade scale where beginning wages tend to be half or less the level in the upper ranges. Cadre and technicians seem to be paid salaries well above the top level in the regular wage scale. The disparity in incomes generated by these differences is not large by private economy standards for either poor or rich countries, but it is not insignificant either. Recent attempts have been made to narrow the income gap by upgrading lower level wages without raising those in the upper ranges, or by promoting workers to higher grades so that a bunching in the upper levels exists. But these attempts do not seem to be widely popular, and strikes and work stoppages apparently have occurred in some areas. The current movement to study the theory of the dictatorship of the proletariat is designed to educate the workers on the desirability and need for uniform wages, but it also is a convenient way to postpone significant movement toward that goal while still recognizing its importance politically.

Distribution patterns in rural areas are more heterogeneous and complex than in urban areas. Work points, not wages, are the primary mechanism for compensating agricultural (and some rural industrial) labor. Each laborer finds the worth of a full day's work of different kinds collectively evaluated once a year. The criteria of evaluation vary from team to team and from commune to commune. All units give heavy weight to physical effort exerted and to skill levels; units also make adjustments for political consciousness. The number of work points earned each day is recorded in the books of the accounting unit, usually the production team (which tends to be a small village) although some "politically advanced" areas now use the production brigade (a cluster of perhaps ten to twelve villages) as the accounting unit. Communes are an important link between the villages and the central government (at the county level), but they do not seem to serve as the accounting unit.

At the end of a production year the gross value of output for the production unit is calculated. After subtracting costs for purchased inputs, taxes owed to the State, and deductions for various welfare funds within the administrative control of the commune (to pay for the the universal health insurance, investment or other accumulation funds, care for the aged, schools, and the like), the net value of output for the accounting unit remains to be allocated to individuals. The allocation is made simply by determining the total number of work points earned within the production team or brigade during the year and then the average value of each work point. Each individual then draws an amount equal to his or her total work points times the average value per work point. Typically, food withdrawals are made in advance of the final reckoning to carry households until the harvest, and deductions for these are made in the final reckoning at the State price for grain. In advanced agricultural areas households are free to buy as much grain as they need, within the limit set by their total accumulation of work points (and the likely value of those work points).

The level of accounting is the critical variable in distinguishing the Chinese system from traditional economic models. If the accounting unit were the individual, then the system would resemble a pure private agricultural wage economy. If the unit were the household, the system would resemble a traditional subsistence economy. As groups of households and entire villages are pulled into the accounting unit, the level of risk for an individual falls but so too does his perception of the link between his own effort and the resulting size of the harvest. Since work points do not depend on actual productivity but only on work effort, the larger accounting units tend to broaden the guarantee that everyone receives access to an adequate harvest. For example, two villages, one with extremely poor soil and one with rich soil, will have very different food consumption (or income) levels depending on whether they are two separate accounting units or whether both are included in a single accounting unit. In the separate case both sets of villagers can work equally hard, and yet one will prosper and the other will not. If both villages are in the same accounting unit, neither will face starvation, but the village with better resources will not prosper as much.

Not surprisingly, the type of income redistribution inherent in this second example has not proved popular with the more prosperous Chinese villagers. While there has been general willingness to incorporate families within a village or small area under the collective wing, this has been aided by familial ties and a strong traditional sense of community. These instincts have been reinforced by not pushing income redistribution very far. Accounting units tend to incorporate relatively homogeneous agricultural resources, so that it is easier to share the resulting output on the basis of work effort expended. Consequently the question of substantial differences in incomes and living standards among brigades and communes has already emerged as a major challenge to Chinese leaders. Disparities of at least two to one can be observed between wealthier and poorer brigades within some communes, and of perhaps four or five to one between communes. These differences raise an inevitable pressure to broaden the accounting unit as a means of narrowing disparities in income, but so far the pressure has had little impact. The Chinese leadership has repeatedly emphasized that the major reason for differentiating productivity and income levels is the willingness of the people to put "politics in command."

National agricultural policy is encapsulated in the motto, "In agriculture, learn from Da Zhai." Despite the most barren land and limited water resources imaginable, the Da Zhai production brigade succeeded in achieving high and stable yields for food grains, diversifying their agriculture through mechanization, and rebuilding their miserable village into a town that regularly receives international visitors among the thousands of Chinese who daily make a virtual pilgrimage to view the miracle. The lesson of Da Zhai is startling and simple: Do not complain about lack of resources. Do not ask assistance from the State. Mobilize the workers and set them to transforming the fields, to finding water, to digging coal, and to making cement. Higher living standards are available to any production unit that has the political will to mobilize. And the rewards will accrue to those who earn them.

A strong material incentive exists to increase production. The incentive in the first instance is to the accounting unit collectively. But since the rural Chinese seem to have found a satisfactory balance between the individual and society at the level of the production team, the incentive to individuals are perceptible. Strong political leadership at the team level can make the vision of the collective production gains quite real for the individual. The tension between distributional equity and private incentives is used creatively to set the task of local political cadre. If the cadre are good, prosperity grows. If they are not, backwardness continues until either the peasants force the issue or higher levels select new leaders.

## Prices

Implicit in the network of physical changes occurring in commune agriculture is an entire set of financial incentives and flows that reflect the accounting needed to make the system function. Wages and work points measure only the accounting prices for the labor flows. Similar accounting must be done for the machinery, fertilizer, electricity, and other commodities and inputs. The accounting is usally in physical units and labor work points for flows entirely within the accounting unit, but accounting for flows from one unit to another and, more importantly, from one level to another is nearly always done with prices. The levels at which these prices are set and the extent to which they change are an extremely important part of the overall climate of inducement to increase food production.

The price of food grain relative to the prices of critical inputs needed to produce food grain, and especially the fertilizer price, is a critical variable in determining the climate of production incentives. In the decision making of market-oriented farmers in Asia, the evidence is strong that this grain/fertilizer price ratio plays a major role. The evidence suggests that the variable is important in China also, but that important differences exist. Increasing fertilizer applications is a major source of higher food grain yields once the agronomic potential has been generated by means of water control, improved cultivation practices, and the availability of high-yielding varieties. Within a given price context fertilizer use can be increased, often dramatically, by policies that reduce the risks of using fertilizer and that develop farmers' understanding of the yield increments to be expected from fertilizer applications. But in China, as elsewhere in Asia, the price context itself is used as a significant part of the overall package of inducements to raise yields.

Prices for both grain and fertilizer are set by the State, and no trading of either commodity is permitted in free markets. The control of food grain prices especially seems to have been effective for over a decade. At the same time that urban prices have remained stable, the farm prices have been raised somewhat on several occasions (requiring some State subsidy to pay the marketing costs). As rural fertilizer factories sprang up and imported fertilizers became more widely available, the rural prices of chemical nutrients have been reduced. The very conscious effect has been to raise the grain/fertilizer price ratio as an inducement to production teams to intensify fertilizer applications as part of their effort to achieve higher yields. The intentional policy of using price incentives in this effort is seen even more clearly in the premium prices paid by the State for sales of grain above a commune's basic quota. This premium seems to range from 20 to 50 percent above the basic quota price.

Average rice yields in China are somewhat higher, given the price for within-quota rice, than would be suggested by the experience of six other tropical rice-growing countries. The price-yield relationship is even more impressive for the high and stable yield areas of China which are able to produce enough surplus grain to earn the premium, above-quota price. Indeed, these areas are as productive as the rice areas of Taiwan. They demonstrate how remarkably successful China has been relative to other Asian experience in integrating a package of yield-increasing technology into an atmosphere made financially attractive by very low risks and high awareness of input productivity. The high and stable rice-yielding areas of China are consistently impressive for the uniformity of the fields, a uniformity not to be seen elsewhere in Asia. It is attributable to meticulous cultivation organized collectively and spurred by a set of incentives that reward success.

## Access to Food

Providing access to locally self-produced food is not a major problem once the production effort has succeeded. But two other difficult problems remain. First, in the rural areas, what is to be done about villages, families and individuals that are unable to share in a successful production effort? Second, how are food supplies to be guaranteed in urban areas?

The problem of excluded individuals and families is not widespread in China because of the strength of the extended family bonds. Three-generation households are still the typical case and are encouraged by the government. The cccasional individuals who do not fit into a family and who cannot work are cared for in special homes run with local welfare funds. Families with too few able-bodied workers to earn sufficient work points to provide adequate food are supplied from local reserves accumulated as part of the welfare fund. Decisions on the size of this fund and the distributions from it are made by all members of the production unit; the procedure resembles collective charitable action much more than a bureaucratic welfare scheme. Since the recipients are always well known by the collective decision-making group (indeed they are usually part of it), few opportunities for abuses exist.

Areas that have not managed to achieve high and stable yields for their basic food grains are much more vulnerable to natural calamity. Drought or floods would cause general starvation within localized areas if grain supplies from outside the afflicted area were not provided quickly and cheaply. The central and provincial governments have been very successful in building reserves from domestic surpluses and from imports to provide such grain, and no significant famines have been reported in China since the founding of the People's Republic. (During the bad harvests from 1959 to 1961 famines were avoided by careful distribution to the neediest areas; stores of grain were not available.) This impressive achievement has been possible, of course, only because of the rapid improvement of substantial portions of Chinese agriculture. Those rural areas that have received emergency grain supplies have also been pushed hard toward local self-sufficiency. The model of Da Zhai is a constant embarrassment to any locality that must receive grain from the State. No local political leadership can expect to survive for long if it must resort regularly to State grain supplies. It is true that communes well suited to producing high yields of important industrial crops, especially cotton and silk, are permitted to buy grain regularly from the State; but even these communes are not permitted to eliminate grain production entirely.

The net result in the rural areas has been firm guarantees that no one will starve, but also equally firm pressures for that guarantee to be made good from local resources. The only way for a region to join in the promise of better living standards is to make the political commitment to local food self-sufficiency. Once such an effort is clearly underway, the State has mechanisms to provide assistance--access to special steels and compressors needed to build small-scale fertilizer factories, access to certain critical machine tools to begin a local agricultural machinery industry, and access to engines and sometimes tractors from State factories. But such access comes only after the local commitment; the rural communes, brigades, and teams must take the initiative.

Providing the food supplies to the cities is an entirely different task. There can be no quid pro quo of food production effort in return for guarantees of emergency food supplies when deficits hit. Cities are by their very nature centers of continuing food deficit. This perpetual need, and the social investment required to keep a person in a city, are the major reasons the Chinese have stopped the growth of cities. They have even sent many people back to their villages, where they can produce some of their own food themselves and also diminish the food deficit in the city.

The State has four primary sources of grain supplies for urban areas. The agricultural tax provides about one third of all grain deliveries to the State. The amount is relatively fixed because the rate is set per hectare and does not change when yields change. There is little opportunity for significant extension of cultivated acreage in China, and land reclaimed and improved by terracing, water conservancy, and other investments is temporarily exempted from taxation. The leadership is loath to raise the land tax rate because of the adverse effect on incentives to raise yields. Little flexibility exists with this grain source, and there is small prospect for growth.

Commune grain sales to the State, according to quotas set by historical productivity levels, provide the rest of urban grain supplies procured internally by the State. The price of sales within the quota has gradually increased since 1949, but, relative to fertilizer prices at least, it is low by other Asian standards. In 1970, for instance, when world rice prices were at their lowest in many years, the relative price paid for within-quota rice in China was about the same as the floor price paid in Indonesia; only Burma and Thailand paid their farmers less. In Indonesia, however, this price was substantially higher than farmers had received historically, and farmers began to respond enthusiastically. In China, where such prices had been guaranteed for much longer, the production response was more nearly complete. Grain quotas seem to be raised periodically, but not as a regular response to higher yields. The attempt to keep the two separate is made for incentive reasons because sales to the State above the quota receive a substantial price premium.

Imports provide a fourth and important source of urban grain. Wheat imports in both 1973 and 1974 exceeded five million tons, most of which were allocated for urban consumption. Such imports, after the claim in 1971 that China was self-sufficient in food, need to be viewed in their proper context. During the same years China exported about two million tons of rice at significantly higher prices than it paid for wheat, a neat calorie arbitrage. Secondly, transportation facilities to bring rural grain to urban cities are limited and heavily overworked. Since Chairman Mao's call to "store grain everywhere" the decision has been made to build significant rural reserves of grain rather than burden the transportation network by moving the surplus to the cities. Imports then have served to build urban reserves for possible hard times ahead, and at the same time to free railroads and trucks for higher priority shipments.

## Rationing

With adequate urban grain supplies assured, the mechanism of distribution remains to be discussed. The system of universal grain rationing for urban dwellers is without doubt one of the major factors which makes the Chinese system unique and successful. Cooking oil and cotton cloth are also rationed. Families receive food grain ration coupons in quantities determined by the age and composition of the family and by the occupation of the wage earners. The rations are presently large enough so that many families do not consume their entire allotment. To discourage waste and the sale of surplus coupons, "savings accounts" for grain have been set up where families may turn in their surplus food coupons each month and accumulate reserves that can be drawn on for special feasts at weddings, holidays, and so on. The grain is not physically stored in a warehouse, but as long as confidence exists that the grain will be available when needed, small reserves are sufficient. The system itself seems to have engendered the feeling among urban families that food is plentiful. Their ration supplies, bought at low and guaranteed prices, are more than adequate. No household hoarding is needed. It is far better to let the State store the grain and to avoid the trouble and expense. Since hoarding greatly exacerbates what may be only marginal scarcity, this scheme has an enormous social payoff. Occasional slight shortages do not get turned into food panics.

The system of rationing the minimum necessities of life so they can be sold at very low prices also solves the problem of access to food supplies for the poorest of the population. Apprentice and low grade worker wages are very low in China, and even with cheap housing, medical care, and transportation, such workers would be unable to compete on a price basis for food. The rationing system guarantees that everyone has access to basic food and clothing. The poorest people will have little access to anything else because meat is expensive, and so are the light industrial products widely available throughout China. But, as the Chinese are quick to point out, China is still a very poor country. The wonder is not that many families cannot afford bicycles, transistor radios, or daily servings of meat, but that all can have three adequate, if starchy, meals each day. The magnitude of this accomplishment in today's hungry world must not be lost in either polemics or adulation. Hard work, sensible and sensitive policies, and an amazing pragmatism and flexibility in the face of failures are the ingredients of China's success.

[Extracted from Food Research Institute Studies, Vol. XV No. 1, 1976, pp. 53-67. Copyright © Board of Trustees of the Leland Stanford Jr. University, Stanford, California.]

# Food Security: An Insurance Approach

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[Efforts to obtain security in food supplies of the developing countries by price stabilization and a buffer stock face various difficulties. An insurance approach, with or without an international grain reserve, could provide an alternative offering additional benefits. A particular type of scheme to insure countries against the hazard of major increases in import costs if food consumption levels are to be maintained is described; its probable costs under different operating rules are estimated, and do not seem unreasonable.]

Much of the debate in recent years over how to attain food security has concentrated on the desirability of accumulating large buffer stocks with the objective of stabilizing the world price of grains. A number of developed countries, both importers and exporters, advocate such an approach for reasons having to do with the operation of their domestic food and agricultural policies. For developing countries, price stability resulting from buffer stocks would mean moderation of the often wide fluctuations in foreign exchange expenditures required to purchase food imports. But even with grain price stabilization, a country will still have a food insecurity problem to the extent that its domestic production fluctuates.

Apart from the degree of food security provided, several problems are inherent in such an approach. It is not clear that nations will be able to agree on the size, location, price bands and administration of the buffer stocks that would form the backbone of a price stabilization scheme. There are important differences among major participants about what production adjustment and trade policy measures should be used if buffer

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stocks are not adequate to keep prices within the specified range. If a group of countries reached agreement on buffer stocks without inclusive participation, member countries would want to exclude non-member countries from the benefits of stable prices. To do this, members in the scheme would have to design some system of export controls or discriminatory pricing to bar non-members from reaping benefits, and such action would invite political or trade retaliation that could ultimately break the system. And even if a group of nations could agree in principle on a price stabilizing arrangement, agreement on a cost-sharing formula would be difficult to work out. It is not possible to estimate accurately the actual monetary costs and benefits for all the participating nations. Moreover, a price stabilizing arrangement does not allow individual countries to select the degree of food security they desire, and thus does not allow them to reduce their share in the cost. In some countries food production is highly variable, in others relatively stable; some nations have enough foreign exchange to absorb variations in domestic production by buying grain in the international market while others do not. Therefore, the degree of food security desired will vary.

Finally, pursuit of short-run self-interest by grain exporters and importers thwarts the negotiation and implementation of a price stabilization arrangement. During years of good harvests, when low grain prices and ample supplies encourage the initiation of a buffer stock system, importing nations see no urgent need for one. But, when poor harvests have forced grain prices up, exporting countries show little interest in buffer stocks that would set an upper limit on the international grain price. This obstacle to grain stocks clearly would disappear if policy makers took longer-term considerations into account. However, the usually short planning horizon of governments and the political pressures of interest groups in both exporting and importing nations bias decisions toward immediate gains. As a result, proposals for grain buffer stocks face serious obstacles caused by the divergence of short-run interests.

## Description of the Insurance Approach

By limiting the scope of an agreement and specifically addressing the needs of food-deficit developing countries, the international community could avoid some of the problems associated with a full-scale market-price stabilization agreement. One way would be to design an agreement along insurance principles.

The two sources of food insecurity in developing countries are: (1) a temporary reduction in domestic food production, and (2) a temporary increase in international foodgrain prices. If a proposal deals only with the first source of food insecurity, it implicitly assumes that food-deficit developing countries can overcome the second source by varying their foreign exchange expenditure on food imports. But such variable spending of scarce foreign exchange could severely hamper overall economic development in many developing countries. Therefore, to protect developing countries from both sources of food insecurity, a food security scheme must deal with fluctuations in their food import expenditures.

This study follows that approach in principle, with certain refinements. First, rather than treating developing countries as a group, this study estimates the level and variability of grain production and the import requirements of each country individually, taking production and consumption growth into account. Second, it clearly specifies operating rules at the country level, allowing an objective estimate of benefits received by each country. Finally, this study estimates the cost of an insurance scheme for a period of five consecutive years rather than for a single isolated year. The specified objectives of the food security scheme analyzed here are: (1) to permit developing countries to stabilize food consumption within a range of projected food demand, and (2) to permit developing countries to stabilize their food import bill within a range of their trend import bill while stabilizing food consumption. "Adjusted target consumption," which is the consumption level to be defended by the system, will remain between 95 and 100 percent of the cereal demand projected for each country. A country's actual consumption levels might be higher or lower than adjusted target consumption; but adjusted target consumption is the basis for determining year-to-year transactions between a country and the system.

In years of very high world prices and/or very low domestic production, a country could become eligible to draw from the system's resources in order to maintain its adjusted target consumption level. Withdrawals from the system depend on the variability of each country's cereal import bill, and on the degree of insurance desired. (Throughout this paper, the term cereal is used to refer to wheat, rice and feed-grains; wheat is taken as the basic staple commodity, and the value of cereal imports is computed as if these imports were composed entirely of wheat.) The system would make payments only for the amount by which a country's actual import bill exceeds a certain percentage of its trend cereal import bill. Should a country desire a high level of insurance, it could set this uninsured import bill level very low, and thus draw frequently from the system. This discussion assumes an uninsured level of 110 percent for all countries (two alternative levels of 120 and 130 percent are evaluated later). The amount of compensation due to a country is calculated by first computing the country's target food imports in a given year (i.e., adjusted target consumption minus current production), and then valuing these imports at the current world price. If the value of target imports exceeds 110 percent of its trend import bill (i.e., the cost of its imports as projected from past trend), then the country is eligible for compensation from the system for the excess bill over 110 percent of the trend value.

A system which requires a country to make some adjustment in consumption before providing compensation payments creates an incentive to maintain production at least at its trend level. But if the system provided coverage for a full 100 percent of each country's projected demand, then there would be no means of preventing a country from drawing excessive short-term benefits by deliberately underreporting domestic production, or reducing its resources allocated to food production.

An international food insurance scheme that would provide member countries the resources to defend their consumption can operate in either of two ways: (1) the scheme can serve as a purely financial mechanism that provides member countries with funds to cover overruns in their cereal import bill; or (2) the insurance scheme can operate a limited size grain reserve in addition to the financial mechanism; grain would be released to eligible member countries when world food supplies are very short. Both of these alternatives will be examined.

A food insurance scheme operating as a purely financial compensatory mechanism implies that the system provides member countries with the funds necessary to cover overruns in their cereal import bill. Recipient countries use these funds to import food to meet their consumption targets.

Table 1 presents several possible transactions between a hypothetical country and the system. In year 1, actual production in the country in question (row 7) is 90 percent of trend (rows 2 and 9). The rules of the system set adjusted target consumption at 95 percent of projected demand, or 10.45 million metric tons (row 9). The difference between adjusted target consumption and actual production (row 10) multiplied by the current world price (row 1) yields the size of the target import bill (row 11). Because the target import bill for year 1 ($137.8 million) is less than 110 percent of the trend import bill ($165 million) (row 6), the country receives no compensation from the system (row 12). In year 2, actual production is 98.06 percent of trend and adjusted target consumption is set at 11.18 million metric tons (i.e., 98.06 percent of projected demand). With the target import bill smaller than 110 percent of trend, the country again receives no compensation in year 2. In the third year, actual production exceeds trend, so adjusted target consumption equals projected demand. The combination of a good domestic crop and a low world price during this year results in a target import bill considerably lower than the trend import bill. The country is again ineligible for compensation from the system. In year 4, however, low domestic production and high world price result in a much higher import bill. The target import bill equals $395.0 million, considerably more than 110 percent of trend import bill (which is equal to $214.5 million). Thus, the

## Table 1— How a food insurance scheme operates as a compensatory financing mechanism for a hypothetical country during a five-year period

| | Year 1 | Year 2 | Year 3 | Year 4 | Year 5 |
|---|---|---|---|---|---|
| 1. Current world price of wheat ($/MT) a/ | 95.0 | 140.0 | 110.0 | 250.0 | 180.0 |
| 2. Cereal production trend (million MT) | 10.0 | 10.3 | 10.7 | 11.2 | 11.7 |
| 3. Projected cereal demand (million MT) | 11.0 | 11.4 | 11.9 | 12.5 | 13.1 |
| 4. Trend cereal imports (million MT) b/ | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 |
| 5. Trend cereal import bill (million $) c/ | 150.0 | 165.0 | 180.0 | 195.0 | 210.0 |
| 6. 110 percent of trend import bill (million $) | 165.0 | 181.5 | 198.0 | 214.5 | 231.0 |
| 7. Actual cereal production (million MT) | 9.0 | 10.1 | 11.0 | 10.3 | 11.8 |
| 8. Actual production as percentage of trend production (%) d/ | 90.0 | 98.0 | 102.8 | 92.0 | 100.9 |
| 9 Adjusted target consumption (million MT) e/ | 10.45 | 11.18 | 11.90 | 11.88 | 13.1 |
| 10 Target cereal imports (million MT) f/ | 1.45 | 1.08 | 0.9 | 1.58 | 1.3 |
| 11 Bill for target imports (million $) g/ | 137.8 | 151.2 | 99.0 | 395.0 | 234.0 |
| 12. Compensation to country (million $) h/ | 0.0 | 0.0 | 0.0 | 180.5 | 3.0 |

a/ For this illustration only, assume that the average world price of wheat equals $150/metric ton.

b/ Computed as the difference between row 3 and row 2.

c/ Computed as the product of row 4 and the assumed average world price of wheat ($150/metric ton).

d/ Computed as the ratio between row 7 and row 2.

e/ Computed by adjusting projected demand (row 3) on the basis of the values of row 8 as explained in the text.

f/ Computed as the difference between row 9 and row 7.

g/ Computed as the product of row 10 and row 1.

h/ Computed as the difference between row 11 and row 6 when the former is larger than the latter.

country is eligible for compensation in the amount of $180.5 million ($395.0 million minus $214.5 million). Finally, in year 5, although the country has a better than average crop of its own, a continued high world price results in an import bill that still exceeds 110 percent of trend import bill. Thus, the country receives compensation in the amount of $3 million.

A food insurance scheme as a combined grain reserve and compensatory financing mechanism. A system that used a grain reserve in conjunction with a compensatory financing mechanism might provide a more cost-effective way of achieving the same objectives. Moreover, the presence of a grain reserve adds an important supply guarantee to the system. In high-price years commercial stocks are ordinarily very low or nearly depleted, so that merely providing financing in these years cannot guarantee availability of supplies. In fact, compensatory payments may bring higher prices and greater financial strain on food importing countries, as more buyers bid for scarce supplies on the world market. Exporting countries may also prefer a system with a grain reserve, since the reserve would protect them against consumption adjustments or the need to impose export controls during high-price years. Appropriately managed, a relatively small reserve could help to guarantee supplies and conceivably reduce the cost of the system, while minimizing its disruptive effects on the international grain market.

A food security system with a limited reserve would have to specify price levels at which it would acquire and release grain. The correct choice of these price levels is crucial to the system's success. On the one hand, a low acquisition price and a high release price mean less interference with the world grain market. On the other hand, there should be at least a reasonable probability that the world price will trigger acquisition and release sometime during the period for which an international insurance scheme is negotiated if it is to serve its purpose.

If, for example, a food insurance scheme has an initial projected life of five years, a release price reached in only one year out of thirty would be unrealistic, since there would be a very low probability that the system would use its grain reserve. Conversely, a release price that is reached in two years out of four would interfere unnecessarily with the free market. With these considerations in mind, a release price which will be exceeded in one year out of five, and an acquisition price which will be exceeded in four years out of five, have been assumed. Given the world price distribution for wheat (i.e., its variations over a previous period), an acquisition price of $105 per metric ton (with about 80 percent probability of being exceeded) and a release price of $200 per metric ton (with about 20 percent probability of being exceeded) can be specified. Using these prices, the system could expect to acquire grain in one year out of five on average, and to release it in one year out of five.

Once the world price reaches the release price, production levels in member countries will determine which ones are eligible for compensation in the form of grain. When high prices trigger the grain release mechanism, countries whose production falls short of trend by more than five percent are eligible to bring their grain supplies up to 95 percent of trend by drawing upon the system's reserves, to the extent that such reserves are available.

Thus, consider again the hypothetical country illustrated in Table 1. During the year 4, the high-price year, domestic production in the country in question is 92 percent of trend production, so the country is eligible to draw from the grain reserve facility of the system. The 95 percent level of trend production equals 10.64 million metric tons, so the country receives 0.34 million metric tons (10.64 minus 10.30) of grain. Use of the reserves reduces the compensatory financing received by the country in question for that year by the value of the grain released to it--i.e., by $85 million (0.34 x $250). The country receives the remaining $95.5 million (180.5 minus 85) in compensatory funds. If the grain available in the grain reserve facility of the system is not enough to cover all requests, then each country's allotment is reduced in proportion to the available reserve.

## Cost of the Scheme Under Alternative Rules of Operation

The costs of operating a scheme of the general type described for 65 Third World countries were estimated, based on data for 1960-75. [For particulars on methods of estimation, see original study.]

Alternative insurance levels. The criterion for a country's eligibility for compensation from the scheme in a particular year is the comparison of its current cereal import bill with its trend import bill. The initial analysis assumed an uninsured import bill of 110 percent for all countries; that is, when a country's current import bill exceeds 110 percent of its trend import bill the country is eligible for the amount of this excess. To examine the sensitivity of cost to the level of insurance provided by the scheme, alternative levels of 120 and 130 percent for all countries have been evaluated. Under these alternatives each country is eligible for compensation from the scheme when its cereal import bill exceeds 120 percent or 130 percent of its trend bill. (Although it would be possible under this scheme for countries to select the insurance level desired, this analysis does not compute the cost of a scheme which assigns different insurance levels to different countries.)

Table 2 presents the overall cost of the scheme under these three alternative insurance levels. The total cost values in this and the next table are expressed as present values of the estimated stream of expected costs, discounted at an 8 percent rate. The figures show that a higher uninsured level reduces the cost of the scheme substantially. Operating the scheme as a compensatory financing mechanism at a 120 percent uninsured level results in a cost reduction of $760 million compared to operating the scheme at a 110 percent level. A 130 percent level further reduces the cost by $658 million.

TABLE 2

**Expected present value of the cost of the scheme operating under alternative insurance levels**

| Cost Components b/ | Scheme Operating as a Compensatory Financing Mechanism Only |  |  | Scheme Operating as a Combination of a Compensatory Financing Mechanism with 20 MT of Grain Reserve a/ |  |  |
|---|---|---|---|---|---|---|
|  | Uninsured Import Bill Level |  |  | Uninsured Import Bill Level |  |  |
|  | 110 percent | 120 percent | 130 percent | 110 percent | 120 percent | 130 percent |
|  |  |  | (million dollars) |  |  |  |
| Cost of compensatory financing | 5,108 | 4,348 | 3,690 | 4,006 | 3,247 | 2,603 |
| Cost of grain reserve |  |  |  |  |  |  |
| Acquisition cost c/ | ... | ... | ... | 1,800 | 1,800 | 1,800 |
| Carrying cost d/ | ... | ... | ... | 775 | 775 | 777 |
| Salvage value e/ | ... | ... | ... | 1,426 | 1,426 | 1,436 |
| Total | ... | ... | ... | 1,149 | 1,149 | 1,141 |
| Total cost of the scheme | 5,108 | 4,348 | 3,690 | 5,155 | 4,396 | 3,744 |

a/ The compensations are in the form of funds when the world wheat price is below $200/metric ton. When the world wheat price exceeds $200/metric ton, part of the compensations are in the form of grain valued at the world price. The grain is released to countries that experience greater than 5 percent production shortfalls and in amounts (to the extent available) to bring the physical availability of grain in every country to 95 percent of production trend.

b/ In computing present values a discount rate of 8 percent has been assumed.

c/ An acquisition price of $90/metric ton has been assumed.

d/ The carrying cost was calculated on the basis of a variable rental cost for storage facilities of $10/metric ton per year.

e/ The salvage value of the residual grain in the system at the end of the five-year period was based on the prevailing market price for that year.

The costs for the same three insured levels for a scheme operating with a 20 million metric ton grain reserve in addition to the compensatory financing mechanism are practically the same as those just mentioned. It should be noted that almost all of the reduction in the total cost of the scheme comes from reductions in its compensatory financing component; the grain released from the system is the same under all three alternatives. This implies that regardless of the level of insurance provided, countries will not receive grain from the scheme as part of their compensation until their cereal import bills substantially exceed 130 percent of their trend import bills.

Alternative rules for grain release. In the preceding analysis two factors trigger the release of grain from the grain reserve facility: (1) the world price of wheat; and (2) individual country production shortfalls. The system releases grain only in years when price rises above $200 per metric ton and then only to countries that experience a shortfall of more than 5 percent during those years. These release rules favor grain release when it is most needed; they might be considered conservative, since there is only 20 percent probability that the world wheat price will rise above $200 per metric ton. Moreover, the probability is very low that some countries will concurrently experience shortfalls greater than 5 percent and high grain prices. Thus, it is interesting to explore alternative release rules for the system. Two alternative grain release rules have been analyzed. In the first, the release price is reduced to $170 per metric ton. (There is a 32 percent probability of exceeding this price.) In the second, the release price is kept at $200 per metric ton, but grain is released to countries with a shortfall greater than 3 percent. Such countries will receive grain, to the extent available in the system, in amounts that bring the physical availability of grain to 97 percent of trend production.

Table 3 shows the results of this analysis. Changing the release rules has very little impact on the expected total cost of the scheme. There is, however, a significant reduction in the compensatory financing component of the cost, particularly with a reduced grain release price of $170 per metric ton, which reduces this cost by almost half a billion dollars. This occurs because more grain is released at a lower release price. Even though the net cost of the grain reserve facility is now higher due to the substantial reduction in the salvage value of the left-over grain at the end of the five-year period, there is still some saving in the total expected cost of the scheme (about $150 million). Moreover, changing the release price trigger from $200 to $170 per metric ton results in a higher probability that grain will be available in later years than changing the production shortfall trigger from 5 to 3 percent. Thus, if a choice between these alternative grain release rules should need to be made, reduction in the release price would be preferable.

## Conclusions

The different cost figures derived in the previous section must be put into proper perspective. One important distinction needs to be made: insurance plans for automobiles, property, or health involve a very large number of participants, and the risk factor is continuous

TABLE 3

Expected present value of the cost of the scheme operating as a compensatory financing mechanism in conjunction with a 20 million metric ton grain reserve under alternative grain release rules

| Cost Components [a] | Release Rules |  |  |
|---|---|---|---|
|  | Price Greater Than $200/Metric Ton Shortfall Greater Than 5 Percent | Price Greater Than $170/Metric Ton Shortfall Greater Than 5 Percent | Price Greater Than $200/Metric Ton Shortfall Greater Than 3 Percent |
|  | (million dollars) |  |  |
| Cost of compensatory financing | 4,006 | 3,548 | 3,874 |
| Cost of grain reserve |  |  |  |
| Acquisition cost | 1,800 | 1,800 | 1,800 |
| Carrying cost | 775 | 713 | 769 |
| Salvage value | 1,426 | 1,068 | 1,323 |
| Total cost of grain reserve | 1,149 | 1,445 | 1,237 |
| Total cost of the scheme | 5,155 | 4,994 | 5,111 |

[a] A discount rate of 8 percent has been assumed. The excess over 110 percent of trend in each country's current cereal import bill is covered.

over time. Thus, the probability that the actual cost will be close to expected cost within a given period is extremely high. An international food insurance scheme, on the other hand, involves both a limited number of participants and a non-continuous risk factor. As a result, the actual cost of operating the scheme for a limited period might differ significantly from its expected cost.

Whatever the form of its financial resources (cash in hand, scheduled premium payments, borrowing capacity, or standby pledges), a food insurance scheme of the type described in this paper will not be established unless it can function at a cost that seems reasonable to its funders. If a high degree of certainty is desired that funds will be available to meet the objectives of a food security scheme, the amount of those funds will have to be very large, even though there is little likelihood that the scheme will actually cost that much. If a lower degree of certainty is acceptable, the potential cost of the insurance scheme will be considerably lower, and the reduced initial capital requirements are more likely to seem reasonable to probable funders of the scheme. In the event that the scheme's funds do not fully cover requirements in some years, target consumption will have to be adjusted proportionately for all participating countries. Since funders will certainly set an upper limit to the financial capacity of any food insurance scheme, the question then becomes, what is the best use of a given level of funds?

To indicate the range of options which funders might want to consider, Table 4 presents the probabilities associated with different cost levels above the expected cost for six scenarios: three insurance levels without reserves, and three insurance levels with a grain reserve of 20 million tons. The associated probabilities indicate the degree of certainty one may have that the funds available will be sufficient to cover all claims against the system, either in the form of money or grain. These clearly show that achieving a high probability that the objectives of the scheme will be met substantially raises the cost of food insurance. For example, under scenario II (scheme operating solely as a compensatory financing mechanism with an uninsured import bill of 120 percent of trend) an additional financial capacity of $0.8 billion increases the probability level from 70 to 75 percent, whereas increasing this probability from 90 to 95 percent requires $3.8 billion.

## TABLE 4

**Funds required to attain a given probability that the scheme will achieve its objectives under alternative methods of operation** [a/]

| Alternative Scenarios on the Operation of the Scheme | Expected Cost | Probability of the Scheme Achieving its Objectives (percent) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 70 | 75 | 80 | 85 | 90 | 95 |
| | | (billion dollars) | | | | | |
| Scheme operating as a compensatory financing mechanism only, with uninsured import bill of | | | | | | | |
| I. 110% of trend | 5.11 | 5.1 | 6.1 | 7.3 | 9.4 | 12.1 | 16.7 |
| II. 120% of trend | 4.35 | 4.1 | 4.9 | 6.0 | 7.9 | 10.7 | 14.5 |
| III. 130% of trend | 3.69 | 3.3 | 3.9 | 4.8 | 6.4 | 8.7 | 12.5 |
| Scheme operating as a compensatory financing mechanism in conjunction with 20 MT of grain reserve, with uninsured import bill of [b/] | | | | | | | |
| IV. 110% of trend | 5.15 | 5.1 | 5.6 | 6.1 | 7.0 | 9.5 | 13.2 |
| V. 120% of trend | 4.40 | 4.1 | 4.4 | 4.8 | 5.7 | 7.7 | 11.2 |
| VI. 130% of trend | 3.74 | 3.3 | 3.6 | 3.9 | 4.7 | 6.1 | 8.9 |

[a/] The scheme attains its objectives when it has adequate funds to compensate member countries under its rules of operation.

[b/] The cost figures under scenarios IV,V and VI include also the net cost of the grain reserve (about $1.1 billion). Grain is released in years when world price exceeds $200 per metric ton, to countries that experience greater than 5 percent production shortfalls in those years and in amounts that will bring the physical availability of supplies (to the extent available in the system) to 95 percent of trend production in all countries.

There is, however, a trade-off between the level of insurance provided and the probability that the objectives of the scheme will be met. For a given financial capacity, a high level of insurance implies a high risk of depleting funds during the last years of the five-year period, thus favoring countries that happen to draw from the scheme early in the period. Therefore, lower insurance coverage (uninsured import bill of 130 percent of trend) with a high probability (90 to 95 percent) of defending the scheme's stated objectives should be preferable to high insurance coverage (uninsured import bill of 110 percent of trend) with a lower probability (70 to 75 percent) of achieving the objectives.

Another consideration is the presence or absence of a grain reserve in the system. Although a grain reserve has virtually no effect on the probability that the scheme will meet its objectives if funding is provided at the expected cost level, additional funding above the expected cost makes a scheme with a grain reserve preferable since it provides a higher probability of achieving its objectives. This effect is greater the larger the size of the reserve. In addition, as shown earlier, a larger reserve provides a higher probability of maintaining supply availability in eligible countries at 95 percent of trend production during high-price years. For these reasons, if a grain reserve were established in conjunction with a compensatory financing mechanism, a grain level of 20 million metric tons for developing countries is suggested.

If it is reasonable to assume that most countries can manage import bill overruns up to 130 percent of the trend import bill without assistance, then the expected present value of the cost of the scheme amounts to about $3.7 billion, of which about $1.1 billion is the cost of a 20 million metric ton grain reserve. This level of funding implies a probability of at least 75 percent that the scheme will successfully defend its objectives. A probability level of 90 percent might require up to $2.4 billion more during the next five-year period.

Source of funds. A crucial component in the success of this scheme is the source of funds needed for its operation. Three alternative approaches to financing the scheme are discussed: (1) self-financing by participating countries; (2) financing primarily by developed countries, with some contributions from developing countries; and (3) financing through a compensatory financing facility of the International Monetary Fund (IMF).

Under the first alternative, member countries would pay annual premiums in proportion to their expected benefits during the five-year period. Countries could pay equal premiums every year or, depending on their year-to-year overall foreign exchange position, they could pay variable annual premiums, larger when foreign exchange position is good, smaller when it is poor. Based on expected total withdrawals, annual premiums by country can be computed. For example, if India had to pay an equal annual premium for the next five years, that premium would range from about $206 million to about $245 million, depending on the level of insurance provided by the scheme. The funding provided by this approach would cover only the expected cost of the scheme, so there would be about 25 percent probability that the scheme's funds would run out. If funds ran out, then the scheme would either have to borrow the cost overruns up to the limit that had been set, or it would have to adjust compensation to eligible countries so that all shared the burden proportionally.

The longer the life of the scheme, the closer the cumulative disbursements at any point of time will be to the cumulative premiums paid in; over a sufficiently long time the scheme itself would be able to repay past debts or to meet by itself any higher than expected current costs. However, if the scheme's life is abruptly terminated after the initial five-year period, the scheme will very likely be left with either a surplus or a deficit in its overall receipts versus disbursements. If the scheme has a balance other than zero on termination, then surpluses should be refunded to and deficits paid by member countries according to their net contributions to the scheme.

In practice, most of the low income countries could not participate in a self-financed scheme without help from developed countries. A food security scheme designed to maintain consumption in developing countries when world prices are high would permit these countries to rely on commercial imports for an increasing percentage of their growing food requirements. Therefore it would be to the advantage of grain exporters in particular to contribute to such a scheme.

Under the second funding alternative, developed countries could provide assistance in a variety of ways. If they chose to do so, they could finance the scheme along with the richer of the developing countries without reference to the distribution of benefits among recipient countries. In this case, donor countries could simply make a collective commitment to finance the scheme at an agreed level. Contributions could be made either in the form of money or in the form of grain set up as a reserve on behalf of the scheme. The cost of setting up the grain reserve could perhaps be the responsibility of the major grain exporters.

Another possibility would be for the donor countries to make commitments to pay a specific percentage of the premiums required from low income countries. A collective effort by developed countries to subsidize the scheme in this way would be desirable from the point of view of recipient countries because it would stipulate a regular flow of financial assistance on terms known in advance. But donor countries might not, for various economic and political reasons, want to commit themselves rigidly to this approach. Many of them might prefer to integrate existing food aid commitments into the scheme, rather than or in addition to providing direct financial subsidies to eligible participants. At present, food aid flows are not always responsive to the particular requirements of recipient countries for which they are intended. Incorporating variable food aid commitments into a food security scheme could remedy this situation.

For countries willing to contribute to the financing of a food insurance scheme through their food aid programs, there are several options. Food aid can be used instead of funds to subsidize the annual premium payments of low income countries. In certain years, the donor nation might make a food aid contribution to a beneficiary country in lieu of a dollar payment to the food insurance scheme. Assume, for example, that an insured country is obligated to pay an annual premium of $10 million to the food security scheme in order to guarantee a certain degree of domestic food security, and that a donor country has pledged a contribution of $5 million (half of the annual premium) on behalf of this country. Suppose that during a normal year the country needs to import $20 million worth of food to meet its consumption targets. Thus, during a normal year this country will have to spend a total of $25 million for food imports plus its participation in the food security scheme. If during a particular year an excessive grain supply in the donor country makes it more desirable for the donor to make its pledged contribution in the form of grain, it can do so by contributing $5 million worth of grain directly to the beneficiary country. The beneficiary country will then have to import only $15 million, and this $5 million savings on its normal import bill plus the $5 million that it has allocated for its participation in the insurance scheme will cover its required premium for that year.

Food aid could also contribute directly to the stabilization of domestic food supply in the recipient country, so that the country will seek a lower degree of protection from the food insurance scheme and thus reduce its annual premium payments. Because domestic supply fluctuations in the recipient country will not in general coincide with the capacity of the donor country to provide food aid, such aid could be used when available to build up a reserve in the recipient country. If stocks created from food aid contributions provided protection against a certain level of domestic production shortfall, then this country should seek coverage from the food insurance scheme in excess of the insurance it provided itself. The premiums needed in this case could be considerably lower than those for full coverage.

A third alternative for funding a food security scheme is through a compensatory financing facility within the IMF. This could be done be creating a new facility specifically to cover overruns in cereal import bills. Or the cereal import bill could be taken into account along with fluctuations in commodity export earnings in determining whether a country is eligible for compensatory financing from the existing facility. Funding through the IMF's compensatory financing facility is a reasonable and just solution because it takes into consideration the foreign exchange position of a country in a given year. More important, the mechanisms that could put such a scheme into operation have already been established and tested, thus precluding the need to establish a new bureaucracy.

In addition to funding arrangements, several other issues will require attention. The foremost problem to be resolved is the identification of reliable data sources to be used in determining which countries are eligible for compensation, and the exact amounts they are eligible for each year. For the initial five-year period, production trends and consumption projections could be estimated with a high degree of accuracy--with some refinement the figures developed in this analysis could be used. The remaining data problem will then be the accuracy of future annual production figures. An international authority would have to determine whether a reported production shortfall is the result of genuine adverse weather conditions, or whether it results from a country cutting back resources in cereal production or deliberately under-reporting its production performance.

Another issue deals with the administration of grain, if grain stocks are held in the system. The problem of trigger prices for starting grain acquisition by the system has been noted. The location of a reserve is another issue that usually emerges in discussions of internationally held grain reserves. Ideally, the grain reserve should be located as close as possible to countries that are more likely to call upon it, assuming that high quality storage facilities exist. Alternatively, on the assumption that grain exporting countries would share in the cost of the scheme either by collectively providing part of the grain reserve or by integrating into the scheme their current food aid programs, grain exporters could hold part of the grain reserve on behalf of the scheme in existing storage facilities. Major grain exporters might be willing to waive carrying costs by including them in the cost of achieving their domestic agricultural policy objectives. The location of grain reserves is a politically sensitive issue for reasons of self-reliance; from a practical point of view it appears that negotiations should focus on a few storage sites close to large contributors and to large expected users of the grain.

Finally, food-deficit developing countries will have to develop internal policy instruments to insure that the steady flow of grain imports obtained by a country's participation in the food insurance scheme reaches the poorest part of its population. In most developing countries agriculture generates a large portion of the income of the poor, so years of poor harvests imply lower buying capacity for a large portion of the population. If the reduction in consumption caused by this decline in effective demand is greater than that tolerated by the food security scheme, countries will need to operate internal food subsidy programs during these years. In addition, since the added supply of grain from an external source will keep prices lower than they would have been otherwise, farm incomes will be rather low from a combination of poor harvests and prices depressed by added supplies. Thus, domestic policy would have to provide income compensation to grain producers to negate possible adverse effects on their earnings.

In summary, this paper has presented a food insurance scheme to deal with the food insecurity problem of food-deficit developing countries, a scheme whose cost proves to be within the reach of the international community. The world food problem is no temporary phenomenon, and the earlier a comprehensive effort, such as the one suggested here, is made, the better. The environment for initiating this effort may never be more favorable in terms of currently available grain supplies. Should this effort prove fruitful, more countries will undoubtedly seek to join, and the chances of alleviating mankind's ultimate problem will be greatly enhanced.

[Extracted from Food Security: An Insurance Approach, Research Report No. 4, September 1978, of the International Food Policy Research Institute (IFPRI), Washington, D.C. Copyright © IFPRI.]

# COMMUNICATIONS

COMMUNICATIONS ARE
REACHING OUT TO DISTANT
VILLAGES VIA TRANSISTOR
RADIO - WORKERS ON A
BANANA PLANTATION IN
ECUADOR ARE SHOWN
LISTENING TO THEIR RADIO.
(PHOTO: WHO, BY PAUL ALMASY)

# The Governance of Broadcasting: Government, the Audience, and Social Groups

Ithiel de Sola Pool

[Broadcasting by radio and television is governed in a variety of ways, depending on national conditions. This article discusses the effectiveness of broadcasting in promoting national development, and some techniques and policies that can increase credibility and acceptance of content.]

How a nation's broadcasting system should be organized depends on what one wants that society to be. Electronic communications are the nervous system of a modern society. They are bound to both reflect and shape people's lives, relations with each other and with their government. Thus, in order to consider alternative ways in which a broadcasting system might be financed, governed and internally organized one ought to start by considering how broadcasting relates to the various social groups that make up a society, what they believe, what other modes of communications are available to them, and what are their development goals.

These are big questions. They are questions of social and political philosophy. Technical questions that social research can answer may be embedded in them, but the full answers involve judgments of value and also the exercise of wisdom in the presence of uncertainty. In short there is no 'state of the art' about how to organize a broadcast system. In the last analysis, the issues involve fundamental political theory. What kind of a state does one want? What kinds of autonomous initiatives contribute to or obstruct national policy?

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A nation is too complex an organism to be moved by a single decision center. The relationship of the parts to the whole in a polity has been the subject of a large literature by such authors as Rousseau, De Tocqueville and Weber. The most important recent contributions to this field have come out of organization theory, which has once more reaffirmed the awareness that the power of any organized unit (be it a firm or nation) is a function of the multiplied initiatives of its many members and therefore depends on their motivations. Innumerable studies by organization theorists have shown lateral and informal communication and multiple initiatives to be the condition of effective achievement of goals defined for the entity by its unifying leadership. These studies have also shown that the key role of the leadership of an organization is most often not its exhortation of the many subordinate leaders who must act, but the presentation of a role model to them. Although these findings have many implications for broadcasting, they lead to no simple solution for broadcasting policy. They are guidelines that should be kept in mind, whatever organizational structure one chooses.

## The Place of Broadcasting in the Total Communication System

In developed societies an integrated communication system serves a multiplicity of purposes. It serves government, business, education, public health and private life. All of these have legitimate communication needs. All of them require an easy flow of messages among all points in the land and among all its citizens. They all share in the use of telephones, printing presses, and broadcasting. One problem confronting developing countries is how to overcome fragmentation by building a comprehensive communication system in which all can talk to all and which serves a variety of social needs.

There is the danger that a communications system designed by one set of institutions and with one set of purposes in mind will fail to meet other needs, i.e., that it will be 'sub-optimized' by being used for one narrow set of purposes. A number of historical examples can be given. In the US, where it started, the telephone system was designed as a business service to provide calls for paying subscribers. Communal needs were not adequately considered. Consequently, fire and police alarms had to be set up on separate and less adequate networks. Phone circuits were not available, as they could have been, as an all-point alarm system instantaneously accessible to anyone from anywhere. Similarly, broadcasting in some countries has developed as an entertainment medium to serve advertisers, and in other places as a propaganda medium for the government. In the former case there is the danger that no provision will be made for allocating some portion of spectrum time for serious broadcast purposes. In the latter, there is the danger that the commodity distribution system of the country will be denied access to the most effective means of informing consumers about the products that business is trying to make available. In both situations, education is likely to get inadequate allocations of broadcast facilities. Somehow, communications facility planning--whether through a market or through consultative processes--should be based on inputs from all institutions as to their prospective needs.

Communication system decisions made today will affect what will be available fifty years hence, and will influence how every element of society functions and performs. Broadcasting is a growing component of a modern communications system. Even in the most advanced countries, where broadcasting has been a live activity for over fifty years, studies show that every year a larger portion of the people's news consumption comes from broadcasting as compared to print media. Educational use of broadcasting is growing almost everywhere. In developing countries where literacy is not universal and where a powerful independent press has yet to take root, broadcasting is even more important. Since the transistor revolution radio has been their main news source.

But even if broadcasting is a country's main source of information and entertainment, it cannot function in isolation from other media. Broadcasting provides a means for support and dissemination of the work of film-makers, traditional artists and journalists, and it depends upon the prior existence of such cadres and their skills. Without them, broadcasting stations would have little to broadcast. Furthermore, broadcasting is only one of the many kinds of communication that a society needs. Being few in number, broadcast channels must necessarily address mass audiences. A vital role remains for print media, film, field agents, poster, telephone, mails and traditional arts that transmit specialized messages to groups both large and small and to individuals. Broadcast planning should take into account its relationship to all these other media.

Comprehensive communication planning requires that broadcasters and the post/telephone/telegraph (PTT) coordinate their long-range planning activities. By working together they can reduce duplication of facilities, and avoid investment in incompatible equipment that may later present obstacles to interconnection. Currently, the principal areas which require close broadcast-telecommunication cooperation are microwave and satellite systems for nationwide message distribution. In the near future, particularly in rapidly developing countries, there will be other areas of overlapping facilities between broadcasting and point-to-point transmission. As spectrum limitations force broadcasting, especially for such purposes as education, to make more use of such media as cable or optical fibers, both broadcasting and point-to-point transmission can share the same networks. Conversely, to reach isolated villages with message traffic, the airwaves and broadcasting receivers may be the most economical means, using off-hours or sidebands or regions of the spectrum which are otherwise unexploited. In short, planning for broadcasting is an integral component of planning for a total communication system and should be carried out with the country's total communication needs in mind.

Not very many countries have done a satisfactory job of comprehensive communication planning. *A priori* one might assume that such planning would be best done in countries with centralized planning and nationalized communications monopolies, but this is not the case. In such societies broadcasting falls under the jurisdiction of politicians who are not much interested in engineering questions, while telecommunications falls under the jurisdiction of engineers. With two powerful national monopolies at the helm one tends to find warring baronies rather than coordination. Thus, in the Soviet Union, the most extreme example of a centrally planned society with nationalized service monopolies, broadcasting is a Party matter under the All Union Committee for Broadcasting, whereas telecommunications are handled within the normal ministerial structure. The relations between them are remote. In Canada, on the other hand, and to a lesser extent in the United States, a loose, decentralized system provides for greater interplay between the two electronic communications sectors. In Canada, broadcasting is handled at the Provincial level, and 40 percent of all homes receive their television signals by cable. Phone companies have assisted in cable-laying, but most cable systems are independent. In parts of Canada the phone company is publicly owned; elsewhere it is private. This variety of patterns has allowed for constructive experimentation with all possible relationships between broadcasting and telecommunications. These experiments are monitored by the Canadian Radio and Television Commission which, like the American Federal Communication Commission, regulates both broadcasting and telephone.

The most typical pattern, worldwide, comes closer to the Soviet than to the Canadian extreme. A government department runs telecommunications. A separate government department or public corporation has a monopoly on broadcasting. There is little interaction between them at the policy level except for the fact that the broadcast network may be a customer of the PTT.

## The Relationship of Broadcasting to Society

In any highly pluralistic society it is essential, both for the different groups themselves and for national integration, that broadcasting present over the air the activities and interests of the various social groups. Radio and TV are mirrors of the society. It is important for the self-esteem of citizens who belong to different social groups that they see themselves in that mirror. It is important for mutual respect and, therefore, for social peace that others in the society see prideful images in that mirror of social groups whom they might otherwise disdain.

The presentation of pluralistic images is more likely to contribute to national unity than to fission. The appearance on the air of figures with whom individual citizens can easily identify contributes to the acceptance of the messages conveyed. In many developing countries fear of regional divisions has prompted governments to centralize all broadcasting in the capital, and to present on the air a single style of person with a single accent. The result has been to deprive provincial authorities of a major tool for implementing regional programs and to give broadcasting an alien, elitist image.

The face and voice of the person on the television screen does not command instant authority by virtue of his role. Unlike the father of a family, the policeman on the block or the mayor of a city, he has no other relations with the audience that draw their respect. His appearance, his style, his way of talking, must somehow draw him out of the crowd. He cannot be characterless. He must be a striking human being with distinctive features that become his hallmark. Features that groups can identify with are particularly important if he is to act as their spokesman. And he must also stand out as a man of exceptional character. In short, a popular broadcasting system with mass appeal requires "stars".

This may seem ironical. Simplistic popular political theorizing sometimes presents a polarity between democracy, in which all are equal and which is therefore leaderless, and aristocracy in which there are elite individuals. However, since ancient times sophisticated political theorists have understood that in some respect the opposite is true. It is oligarchies that most strenuously combat 'the cult of the individual'. Competing oligarchs do not wish anyone among them to develop a mass following. Conversely, democracies, as Plato, Aristotle, Ibn Khaldun, Moise Ostrogorski and Max Weber pointed out, require 'demagogues' (in the Greek sense) or charismatic leaders to mobilize a popular following. Thus, if broadcasting is to serve as an initiator and mobilizer of public action it must do it through distinctive stars with whom people can identify.

A nation is too large an organization to function with all initiative taken at the center. There are limitations of time and attention, as well as limitations of imagination and empathy, both by those at the center and those out at the grass roots. Emotional attachments are strongest to persons with whom one has some human contact, as every politician knows. Television does not change these facts. It should work with them. To be seen on TV is a useful halfway step to being seen in person. However, the face seen on TV whom no one knows or has ever met in person, who has no shared relatives with one's own relatives, who has no known private life like one's own, is simply not as credible as the TV spokesman who is also part of one's own circle. Consensus about the purposes and programs of the center is more likely to be achieved by representatives of diverse elements talking to each group, rather than by appeals from the center itself.

For effective broadcasting by different social groups, it is not enough to present pictures of different regions, costumes and tribes. There is a limit to the extent to which even the most talented producer can create programs which are meaningful to people who differ greatly from himself unless he draws them directly into the production process. Members of the relevant social groups can usefully be involved in the planning and creation of programs. Mechanisms for such participation include advisory committees, local origination, and feedback programming in which local activities are used for program material and members of the group are invited to express their reactions. Such programming can contribute to credibility, and it offers the opportunity of presenting the unity in diversity of the nation.

Credibility. Without credibility among its audience, a broadcasting system is at best a bulletin board for notices and a conduit for entertainment trivia. If a broadcast system is to activate a people it must be trusted.

Credibility is a serious concern, for credibility is a fragile matter. It is easily compromised and hard to regain. Credibility requires that the broadcaster can be counted on by his audience to tell the truth in regard to the things he discusses, and also to address himself to matters which the listener considers important. Evasion as well as distortion compromises credibility. Credibility can also be served by putting spokesmen on the air whom listeners already trust. Credibility is aided by the broadcaster having a status that is recognized as independent from government pressures: discussing issues impartially, presenting alternative views on controversial issues, airing problems that really trouble people, and providing a channel between people and government.

Three additional points need stressing. First, if television is perceived as just a part of some remote elite status or of the government, the suspicion may arise that the medium does not give relevant information or the whole truth. To counter this, the role of television as a professional, free and independent journalistic medium must be assured by its charter. Second, viewers must not think of television programs as shows produced by an insular metropolitan clique. On the contrary, viewers should consider themselves as active participants. This can be achieved in part by a program policy which encourages as much as possible participation by ordinary men and women. For such fieldwork program production, special training should be provided for the program staff. Third, the image which the communicator projects on the screen makes a difference. The broadcast organization should analyze what kind of communicator is desirable in the current political and socio-cultural context.

In many field experiments an attempt has been made to create programming that is credible in rural areas. Senegal, for example, has a weekly program in which an issue is discussed by villagers and tape recorded. The announcer then invites letters from other villages about the same problem, which are then read over the air and answered by a high government official. [See Development Digest October 1974, p. 103.] Experience has shown that when development plans are discussed at the village level and broadcast over the air the interest is greatly enhanced.

## The Role of Broadcasting in Social and Economic Development

Social and economic development is development of people. To achieve it requires learning, motivation and effective communications. A broadcasting system provides the government with means to promote and explain development plans and their implementation, to provide a link between the government and the people.

Too often those who engage in developmental planning think only of providing the economic prerequisites of development such as capital, or, if they think of motivation at all, of economic incentives. While these are important considerations, attention should also be given to psychological planning for mobilization. Broadcasting organizations should be attuned to fulfilling that role. It is one of the main contributions they can make to development. Broadcasting organizations can explain to government departments and other authorities the potential of electronic mass communications in support of development, as well as their limitations. They can advise government and other development agencies on the psychological dimensions of programs, and can advocate before planning and other development agencies the requisite communication aspects and resources for persuasion.

Developmental broadcasting demands close coordination with the concerned government departments and other institutions responsible for implementation. It would be pointless, for instance, to promote a new seed variety if it is unavailable in the localities where it is to be publicized on the radio. Broadcasting for developmental purposes requires very special skills that not all broadcaster have. Development broadcasts should have entertainment value as well as other qualities. Broadcasting organizations in rapidly developing countries must provide training which goes beyond classical broadcasting training and includes an understanding of all aspects of the development process and the use of communications media for it.

As a development agency, a broadcasting organization has the critical responsibility of activating the human potential of the country and its cultural development. This contribution to development can be provided not only by serious educational programs but also by those whose primary aim is entertainment. Entertainment programming can present audiences with role models for new ways of life, and can fulfill an informative role as well as, or even better than, programming which is more purposively informative.

Implications. So far we have laid out some basic considerations for the governance of broadcasting in a rapidly developing country. These include the structure of a total national communication system of which broadcasting is but a part; the social structure of the country; the need to establish credibility with a diverse audience; and the priority of the goals of rapid development. We now turn to some conclusions that seem to follow.

1. *Value of non-broadcast activities to the broadcaster.* Broadcasting cannot be developed in isolation. Along with broadcasting stations, a successful system depends upon the existence of electricity, distributors, and repair shops around the country. Broadcasting requires performers, writers, journalists and directors. The development of national cultural institutions must move forward on many fronts simultaneously. If there is to be appreciation of the country's ancient art, textbooks must teach about it in schools, museums must exhibit it, universities must train historians and archeologists to document it. TV producers must have a source of material available to them. The development of culture is more than development of radio and TV.

Because of their mass appeal radio and TV are apt to move ahead faster than other cultural institutions. They do not require literacy, and reach everywhere at low incremental cost. For its own well-being the broadcasting industry ought to help develop other cultural institutions which would otherwise lag behind. Since such related activities are not central to the organization, a broadcaster might perhaps spin them off when and if they acquire the ability to become self-sustaining. This would be a wise exercise in self-restraint and a way of avoiding the atrophy that often accompanies excessive growth. The unique capability of a broadcasting network to start the ball rolling should be recognized. It knows its audiences. It has the experience. If a broadcasting organization is to fulfill its role as promoter of economic and social development, it must inevitably branch out into auxiliary activities. To teach courses over the air it must distribute associated printed matter. To engage in agricultural advice programs it must maintain liaison with field agents. Its activities must be defined by its substantive goals rather than by a particular means of transmission.

2. *Research provides policy guidance.* Broadcasters need a two-way relationship with their audiences. Credibility as well as effectiveness in promoting development depends upon an understanding of an interaction with the many social groups that make up the audience. Research is an instrument for getting to know the audience better. It is a voice of the audience. It helps the broadcaster avoid the danger of transmitting only the limited views of his own social milieu.

Research takes many forms and requires a variety of skills.

-- Library research contributes to the content of programs.
-- Audience research provides data on audience composition, size, type and interests, and helps broadcasters to be responsive to their audiences.
-- Effects research reveals audience attitudes, values and behavior.
-- Needs analysis at both the national and audience level specifies program requirements.
-- Organizational and systems research on the broadcast institution itself serves to identify the best combination of resources and their management for responding to changing requirements and opportunities.
-- Program testing and the evaluation of pilot material contribute to the development of innovative concepts.

In view of the importance of research and its potential but fragile capability for objectivity, we should consider how research activities ought to be linked to programming and operating policy. Research organizations need budgetary and other flexibility to allow them some freedom of initiative. Autonomy serves both to sustain the creativity of researchers and to stimulate research ideas, the best of which are likely to come out of the researcher's own experience and expertise. At the same time, if the research is to prove of practical use the researchers must maintain close liaison with policy makers. A number of conclusions follow:

(a) Research units ought to report to the highest policy levels. While programming departments may have some internal research requirements, research in general will not be objective nor will its results be properly applied if it is not lifted above the pressures of day-to-day production.

(b) There should be rapid dissemination of research results to all levels of the organizations where they may be used.

(c) Researchers within the broadcasting organization should maintain contact with professional colleagues in other institutions, and should act as translators of research results into terms the policy makers can understand.

(d) Research provides background information and *post facto* evaluation. In addition, by operating in a daily, repetitive manner in the production cycle it should answer questions raised by producers as they arise.

(e) Research may at times provide useful program material by identifying people's interests and concerns.

## Relationship of Broadcasting to the Government

Throughout the world one finds a variety of arrangements for the governance of broadcasting, ranging from pure government monopoly to purely commercial systems. Other arrangements include broadcasting by public corporations, by universities, by churches, by voluntary associations, and by combinations of the above. There may be a single broadcasting organization or several competing ones.

The relationship between management of programming and of transmission also varies. In France and Holland, for example, one monopoly operates the transmitters for several broadcasting organizations. In Holland a number of producing organizations share studios, wavebands and transmitters. In the United States, on the other hand, each broadcasting organization owns its own physical facilities (i.e. "hardware").

The only aspect in the hardware-software relationship that is universal is that, in broadcasting, software (i.e., program contents) considerations are dominant. Whereas in telecommunications systems engineers are generally in charge, in broadcasting organizations political, marketing, and cultural specialists have the upper hand. The top men may be drawn from the fiscal or marketing areas, from programming, or from politics. There may be one production organization or several. The production organization may be an integral part of, or distinct from, the broadcasting stations which create the daily schedule, and also from the transmission organization. Broadcasting stations may be loosely federated into a cooperative network, or run by a national organization. There may be one network or several competing ones. Where there are competing networks there may be a mixed system, as in Britain and the United States, where some networks are private and some are public.

At the structural level there is no single answer to what is the most desirable system for all countries and for all times. The structural form of broadcasting organizations is determined by particular socio-economic, cultural and political factors operating in any given society, the resources available, and the number of channels. Relationships between media and government change as new social, economic and technological environments emerge. In all circumstances, however, broadcasting has relations with government. Government needs channels through which to talk to the people; the people, for their part, need information about their government. Furthermore, it is the government which by law determines the basic policies and structures under which the national communication system operates. Government allocates the broadcasting frequencies. In most countries government provides all or most of the funding for broadcasting. And governments may, by their controls, undercut the effectiveness of broadcasters.

There is need for strong protection of the autonomy of broadcast organizations, whether they are broadcast monopolies or competing networks. This need follows directly from the importance of credibility; to win its listeners' confidence a broadcasting organization must show that it is devoted uncompromisingly to doing its job, and is not the agent of outside forces.

Autonomy means independence of broadcasters in their professional role, not autonomy of a social elite. This latter form of autonomy develops easily because broadcasters are inevitably drawn from the better educated, professional strata of the population. The autonomy that is desired is that of broadcasting professionals acting responsibly. To achieve it while resisting the temptation to become 'a happy few' requires continuous interaction of the independent professionals with their audience by the various means mentioned above: research, feedback and participant programming, and decentralization of the system. Autonomy is fostered by professionalism, protected financing, strong traditions of broadcast independence, and an appropriate structure of the broadcasting organization. Organizational mechanisms that protect broadcasting autonomy include tenure for broadcasting staffs, high position in the state structure for the director general, and governance by a board independent of both the government and the broadcast organization. Such a board of directors can act as an intermediary between the government and the director general in the case of disputes. Its membership may be drawn from universities, journalists' associations, arts and business, or may have members appointed or elected by interested parties such as recognized national associations and the government.

With autonomy goes responsibility. Broadcasting organizations must provide access to the air for diverse elements of the population. This can be done by making available specialized channels, or specialized programs within general channels, through advertisements, public service announcements, interview programs--and most important of all by local and decentralized programming.

Discussions of relationships between power centers such as government and the broadcasting organization often degenerate into assertions of formal authority. It is easier to engage in legalistic definition of roles than to describe how two large organizations interact. The relationships between large social institutions are polymorphous and occur at hundreds of different organizational levels. The symbiotic relations at these levels often determine whether and how policies will be implemented. If intervention and control between government and broadcasting organization were to occur only at the summit level, the real power of one institution over the other would be small because effective exercise of power requires many points of linkage. What is likely to happen if the top authorities are the only point of linkage is a deadlock (not unlike negotiations between superpowers) with each head official unable to yield any point that might open up unforeseen troubles in the large structure below him. Only when middle and lower level personnel interact with one another in the carrying out of program can effective action be taken. In other words, joint programs require that authority be delegated to interagency links.

Financing. A successful broadcasting organization must have an adequate and sufficiently stable source of funds to retain its autonomy. There are various ways in which this could be achieved. License fees seem to provide broadcasters with a stable source of income. But legally imposed fees tend to remain unchanged in the face of inflation and, under usual circumstances, do not provide a satisfactory solution.

Part of the broadcasting revenue may come directly out of the government budget. In the United States, where this is the case for the fourth network, there is currently a lively discussion on how to protect broadcasting funded by the government budget from congressional pressures. A proposal which may be adopted provides for three-year funding, with Congress voting each year on the appropriation for the year three years hence. Since control of events three years in the future is not likely, this scheme would minimize the risk of political interference. To meet the problem of unanticipated inflation, the formula for broadcasting revenue could be related to a fixed percentage of the national budget or to those components of the national budget relevant to communication. But a system fully supported by the government runs the great risk of becoming boring, and reflective of the tastes and views of the civil service. There is no incentive to attract audiences since the revenue does not decline if the audience falls off, and the only people who must be satisfied are those who hold the purse-strings.

A broadcasting system fully paid for by advertisers, on the other hand, tends to produce mass entertainment exclusively since entertainment programs have been shown to achieve much higher audiences than any other offering. Advertisers are not interested in the intensity of viewer enjoyment as long as the viewer watches at all. Even when faced with competition on the air, an advertiser is not prepared to double or triple production budgets to gain a few extra audience percentage points. In the United States he restricts himself to what can be done for about 2 cents per hour per viewer.

The viewer may be willing to pay substantially more if he feels he is getting his money's worth, and may be prepared to subscribe to pay-by-the-show schemes for the sake of quality programming that meets his particular taste. Collecting from the audience program-by-program involves, of course, some additional costs. A scrambling and unscrambling device has to be used, along with record-keeping. This is technically much easier on a cable system than over the air, although the latter is also feasible. Such a device is not necessary where customers pay a flat fee by month or year, as for example paying a license fee at the post office. But under such a system the customer loses his influence over programming. The broadcaster is in control of what is offered and the viewer must accept it. Besides, in a country whose population is not affluent, the fee may slow down TV penetration.

The choice between having payment by the public, the advertisers, or the government is partly a function of who can best afford it. In a poor developing country multinational corporations that wish to advertise may be the readiest source of funds. A pay-by-the-program system requires the potential customers to be reasonably affluent. In some countries the greatest concentration of wealth is in the hands of the government.

The best solution is probably a mixed system, part of which is responsible primarily to audience tests and thereby provides a standard of comparison as to audience receptiveness, part serves primarily government objectives, and part is purely commercial. With broadcasting deriving its revenue from a variety of sources it is important that a substantial portion of the revenue be for general purposes not tied to the special interests of the sponsor. If each government agency--each university, for example--supports programs exclusively in a particular field such as education, health, national culture, etc., and inadequate resources are provided for unsponsored activities, distorted programming will result.

## Internal Organization of the Broadcasting System

Just as there is no single formula for the overall structure of a broadcasting organization or its relation to other authorities, so there is no single formula for its internal structure. That depends on the practices of the country, the past established traditions of the organization, its stage of development, and what makes the people who are doing the job feel comfortable. If there is any one guiding principle it is that broadcasting is a creative activity which must allow scope for a variety of approaches and pluralism of initiatives to avoid the ossification that arises from traditional bureaucratic structures.

Of great importance is decentralization in the broadcasting organization--and not necessarily or exclusively on a geographical basis. There may be functional divisions with each unit responsible for different types of programming, e.g., educational or ethnic. There may even be separate units set up with no clear difference in their characteristics for the explicit purpose of promoting a spirit of competition among similar but independent creative groups. Regional distribution of creative and production activities remains, however, the most important form of decentralization. It serves to overcome the serious problem of gigantism in primate cities which draw to themselves all intellectuals and persons of ability. Geographical decentralization of broadcasting is also important because state and local authorities need access to broadcasting just as much as central authorities do. In education, public health, business enterprise or government the echelons which deal directly with people are those at the local level. Local school authorities, local merchants and local officials must reach people directly. It is they who can make the most and best use of broadcasting for social purposes.

[Extracted from Chapter 6 of Communications Policy for National Development, Editors Majid Teheranian, Farhad Hakimsadeh, Marcello L. Vidale, published by Routledge and Kegan Paul, London and Boston. Copyright © 1977 Iran Communications and Development Institute.]

# A Multinational North-South News Agency

Roger Tartarian

[This article surveys briefly the main issues involved in the differences arising in UNESCO and elsewhere over the treatment of Third World news in the major agencies: Associated Press (AP), Agence France Presse (AFP), Reuters, and United Press International (UPI). It then reviews some of the current proposals for remedy, and concludes with the author's proposal for a joint venture in news gathering.]

This paper seeks to move the debate over imbalances in the international flow of news and information into a consideration of specific ways by which they might be corrected or minimized. It is based on an assumption that there is a fair measure of agreement in both the developed and developing countries that such a problem exists, and that remedies should be pursued in a cooperative vein. Specifically, this paper suggests a study of the feasibility of an operational linkup between some of the principal news agencies of both worlds, so that at least a limited start can be made toward achieving better coverage of the developing world in both the first world and the third world news media. A suggested point of departure is the concept of a multinational news agency that would: (1) be directed jointly by professional journalists from both areas, and (2) serve as a central production and distribution mechanism for news of social, economic, cultural and other development activities in the Third World.

Before considering a more detailed outline of this concept, it is well to review what is meant by some of the widely acknowledged problems in news flow, and to

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confront the hard political and economic realities which exist in the world of news and information and which must inevitably dictate the limits of practical cooperation. Third World criticism of the present international news flow ranges in tone from scholarly to shrill, and includes charges that the western-based news agencies in particular are engaged in deliberate attempts to make young or developing countries look corrupt or inept. Some of this is rooted in emotion fed by the legacy of colonial history. But there is validity to some of the criticism; it would be wrong to try to dismiss it as a manifestation of national paranoia.

Perhaps one of the most reasoned and succinct presentations of the Third World indictment was presented in the 1977 New York conference on the Press in the Third World convened by the Edward R. Murrow Center for Public Diplomacy, a unit of Tuft University's Fletcher School for Law and Diplomacy. The presentation was made by Narinder K. Aggarwala, an Indian journalist serving with the United Nations Development Programme in the Pacific. He said:

> "The Third World's complaint against the international news media is two-fold. First, that only a quarter of the news that goes on the wires of the four major Western news agencies emanates from, or deals with, the developing countries, although they constitute nearly two-thirds of humanity. Second, most of the Third World news is negative and deals with such subjects as shortages, famines, natural disasters and political and military intrigues. The news disseminated by the four transnational news agencies is meant primarily for the users in the developed countries and has a very strong Northern orientation. What the developing countries want is world news by Third World journalists for developing country media use. There is a genuine need for creating a channel through which developing nations can get news about each other, and the industrialized world, from their own perspective."

There is a temptation for some in the west to isolate comments such as Aggarwala's references to "political and military intrigue" and treat them as an implicit Third World demand that the western media stop reporting such events. Obviously, the western media could never accede to such a demand. But more to the point, no such demand is made by the more reasonable critics in the developing countries. What they ask is that the western media, and particularly the western news agencies, not permit fascination with the spectacular or the aberrant to blind them to progress that is achieved more quietly and unspecatacularly in these emerging societies. Moreover, they say, even if your more important subscribers in developed countries are uninterested in our progress, we in the Third World are interested in each other's--and you are reporting it sporadically at best.

There can be no substantial quarrel with these general conclusions about the state of international news flow:

--There is, in fact, imbalance in the flow of news, both in content and in volume, since there is more of it in one direction--moving from the developed to the developing worlds, or, as some commentators put it, from the North to the South, and much less from South to North. It is true that this reflects the relative distribution of global military, economic and political dimensions, but that does not alter the truth that the news imbalance exists. The disposition of news agency staff correspondents around the world indicates where the emphasis of coverage is. AP and UPI probably have more fulltime staff in their London offices than in all of Africa. Reuters and AFP outstaff the American agencies in Africa, but Reuters and probably AFP have more regular staff in the United States than in all of the continent of Africa.

--There is great disparity in the quality and quantity of regional coverage provided by the western agencies of and to the Third World. While Latin America is relatively well covered for the Latin American press, it is not covered as well as is Western Europe. Even so, it is much better covered for regional news than is Asia, and immeasurably better than Africa.

--Agency coverage often tends to seek simplistic solutions, or Cold War ramifications, in situations that are typically Asian, African or Latin American. For example, labels like "anti-American" or "pro-Soviet" can and do mislead when applied to many Third World situations. This can be attributed to institutional rather than ideological attitudes. Regardless of nationality, news agency journalists of all kinds understanably tend to adapt writing styles, choice of "lead" material--indeed, an entire definition of what is "news"--to conform with what they find dominating the wires of their agency. This results in a homogenization by which subtle nuances that are of extreme local importance become levelled out in the interests of distant readers.

--There is an acknowledged tendency among western media, including the news agencies, to devote their greatest attention to the Third World in times of disaster, crisis and confrontation. The agencies are no less interested in disaster, crisis and confrontation when it occurs in the developed world; but their daily file of news of the developed world is vast and variegated, even when there is no crisis. The same is not true of much of the Third World coverage. Staff correspondents are airlifted in to cope with an emergency and depart when it is over. Coverage then reverts to the status quo ante which means, in many or most places, that coverage is left to part-time local journalists or "stringers".

What Third World journalists feel to be especially lacking on the wires of the Big Four is what can only be called news of national and regional development--news acquainting each other with their efforts toward economic, social and cultural progress. This would call for a somewhat different concept of "news" for the big agencies. The international services of the Big Four, for example, are not likely to report the opening of a new cotton processing plant in the southern United States because it does not fit their traditional definition of international news. It is too parochial, too much local fare, for the foreign correspondent. But the same yardstick applied to the opening of a new peanut plant outside Niamey, Niger, can result in a feeling that the agencies are uninterested when there is "positive" news to report from a Third World country. To an editor in Nigeria, the new plant in Niamey could be very significant news indeed, and the failure of the major news services to provide it simply fuels the criticism of their work.

## Non-Aligned News Agency Pool

In 1976 the Non-Aligned News Agency Pool was established by some 85 developing nations to help fill this informational need. There is no evidence yet that it is having any major impact on the flow of news between the participating countries, partly perhaps because its participating national news agencies are themselves largely dependent on the Western wire services for news about their neighbors. An American analysis of the Pool's work during the first quarter of 1977 found that 60% of the news carried by the Pool was provided by just seven countries--Yugoslavia (which operates the Pool's transmissions), 17%; Egypt, 12%; Iraq, 7%; and Cuba, Libya, Sri Lanka and Qatar, 6% each. But even granting that participation is expected to increase, there is some question whether the Non-Aligned Pool can have more than peripheral effect on the international flow of news. In his paper to the Murrow Center conference last year, Aggarwala said, inter alia:

> "In its present form, the (Pool) agreement, for all practical purposes, provides for no more than a mechanism for exchanging official information on news handouts. Its usefulness, other than as a first step measure, is questionable since participating governments are unlikely to force their media to publish news received through the Pool whose credibility they themselves doubt, or whose contents collide with their own or their allies' policies."

This political aspect of the Non-aligned Pool cannot be neutralized. It is inherent in the concept. What the Libyan agency ARNA chooses to send to the Pool, for example, may or may not be what would most interest the readers of Al Ahram in Cairo. That problem can be multiplied by as many times as there are frictions between governments.

The Pool nevertheless represents a positive step in the effort to increase the international flow of information. What governments say to each other or their own people, or the way they view developments at home and abroad, constitute an important ingredient of news. But it is only one of many ingredients, and needs to be kept in perspective. None of this is to suggest that the Nonaligned Pool is incapable of distributing anything that meets the broader definition of news--it can, and it does. But its efforts are clearly having no great impact on international news flow, simply because they are not finding their way into the world's major news streams.

## The Big Four News Agencies

What is equally clear is that this activity would be more effective if it were done in a broader international context in a pattern of cooperation with the major news suppliers of the world. It is here, in seeking to develop this pattern, that hard political realities must be confronted--realities that dictate who can and cannot be expected to be partners in such a venture. It is highly significant that, in his appraisal of the work of the global news services, Narinder Aggarwala speaks of "the four" international news agencies that are in fact the major suppliers of news to newspapers and broadcasters of the world today: The Associated Press and United Press International (United States), Agence France Presse (France), and Reuters (Britain). There are, of course, other large information organizations in the world. But on one of two tests, they differ from the Big Four in very important ways. Some, like West Germany's DPA or Japan's KYODO, are excellent, broad-coverage news organizations but lack the geographical spread of the Big Four. Or they are geographically as widespread, as in the case of the Soviet Union's TASS or China's HSINHUA, but are so organically a part of a political state that they are institutionally incapable of distributing news critical of their governments or their allies. The western Big Four agencies are hardly perfect entities, but they do have the ability to transmit news even when it is critical of their governments and public leaders. Even more, they can, and do, initiate such news through their own investigative reporters.

The importance of the Big Four to governments at large can be illustrated by the fact that their news teleprinters can be found in most Foreign Offices of the world. The TASS teleprinter can perhaps be found as often, but not as often for the same reason. TASS is an excellent source for obtaining a Soviet viewpoint; but it is not the best place to learn that the People's Daily in Peking has devoted its entire front page to an attack on Soviet revisionism, or that Al-Ahram in Cairo has criticized Soviet policy in Africa. The western agencies have no difficulty in comparable situations because they are news agencies in a different sense and not official information organs. This distinction is a vital one because it is the key to credibility, and credibility is the most important asset that journalistic enterprises can possess.

## The Issue of Government Control

This distinction between news and official information also explains the bitter division with UNESCO over the controversial Soviet draft resolution on the "uses" of the mass media by government. The discordant philosophies within UNESCO only foredoom efforts to find a universally acceptable plan to reorder the flow of world information in keeping with the instructions of its General Conference in Nairobi in 1976. The first meeting in December 1977 of UNESCO's International Commission for Study of Communications Problems reflected the virtual impossibility of the task handed it by the Nairobi conference. It was clear from the opening moments that "free and balanced flow of information" meant quite different things to different countries. And after UNESCO Director-General Amadou-Mahtar M'Bow exhorted the delegates to pursue the UNESCO goal of a "new world information order," the chairman of the conference suggested that the delegates first try to agree on what is meant by "new information order," a call that has resounded in UNESCO literature since 1974 despite its apparent ambiguity. UNESCO has become a suspect midwife in the eyes of many western journalists who, rightly or wrongly, are convinced that its staff and its experts are ideologically wedded to fostering state control over media, even where independent systems can exist. Whether or not that is the case, the prospects for UNESCO to provide a solution to the present problem is, by any realistic assessment, dismal at best because of the clashing philosophies of its members regarding control of news.

There can be said to be three types or degrees of control in the world today:

1. Maximum Control: Exists where information media are exclusively state-owned on a permanent, constitutional basis. Regulation of speech and press embraces the entire spectrum of human activity--that is to say, comments about art, literature, music, dress, sport, etc., are as rigidly subject to central authority as are comments about political issues. The Soviet Union and China would be models in this group.

2. Limited Control: Exists where media can be either state-owned or privately owned but where restraints on expression are

largely political. This would apply to much of the Third World and includes places such as Nigeria, the Philippines, etc. where constitutional provisions for a free press are for various reasons suspended by emergency decree, but which remain as long-term objectives.

3. Minimal Control: Exists where the media are exclusively or overwhelmingly independent of government and where limitations on expression are at the lowest of existing levels. Models here would be India, the United States, most of Western Europe, Japan, etc.

It is not only these philosophies that confront UNESCO in its efforts to define such things as "balanced" or "free" flow of news and information. It must also respect the desire of some member states to keep their societies closed to all but rigidly controlled scrutiny from outside, a desire that collides head on with the goal of the western media for free access. The net effect of all such factors is to indicate that the second and third groupings above offer the best possibilities for a measure of cooperation on news and news flow. As limited as this might be, it at least represents the basis for starting a search for remedies in an area where action seems to be overdue.

## Technical Assistance In Communications

There has been some response in the developed countries to the communications problems of the Third World. An important initiative has come from the World Press Freedom Committee, an organization that was founded in 1976 as a joint project of the Inter-American Press Association and the International Press Institute, and which now has some 30 affiliates in the Western Hemisphere, Europe, Australia, Hong Kong and Japan. Led by George Beebe, Associate Publisher of the Miami Herald, and other leading American journalists, this group through a special development committee is raising $1,000,000 to provide technical assistance to Third World media. Its initial grants have included $20,000 to the University of Nairobi School of Journalism, $10,000 towards a reporters training school in Trinidad; and $10,000 for a seminar to train African journalists in economic and financial reporting. As excellent as this project is, however, it does not touch the central part of the present problem: the dissatisfaction in the Third World with the present international news flow as it is provided by the major suppliers, i.e., the Big Four western-based news agencies.

Spokesmen for AFP, AP, Reuters and UPI have repeatedly expressed a readiness to help the various national agencies on a bilateral basis with such things as exchanges of news and training of staff, but they emphasize that it must be on a commercial basis. They themselves lack the resources to finance assistance projects of that kind. Nor can they expand their own coverage of Third World subjects to any appreciable extent in areas where they cannot generate new revenue to cover their costs.

The dilemma of the western agencies is reminiscent of the situation facing the American media for many years with respect to coverage of U.S. national elections. Historically, AP, UPI and the three U.S. television networks each covered the entire country on polling day as well as it could with its own resources. (There is no central official vote counting mechanism in the United States; it is the media that proclaim the winner on election night.) But none could afford to cover the entire country very well by itself. They finally agreed in the mid-1960s to pool funds and have only one large vote-counting apparatus where five lesser ones had always existed. The result was a dramatic improvement, which none of the five partners could possibly have financed itself. It would be impossible, however, to apply that consortium principle to the present situation, even it it were desirable--which it is not. Competition does provide checks and balances, and cartel-like arrangements have their own perils. In any event, the four western news agencies are too sharply competitive, too fiercely independent to consider such joint coverage, even in news-deficit areas. What remains to be explored is whether there is any way to draw them into a cooperative venture with interested Third World agencies without affecting their competitive operations or compromising their independence.

Meanwhile, coverage of much of the Third World remains both sparse and fragmented. The creation of the Non-aligned News Pool has added to the total news potential in the region, but it works in isolation from other entities. Clearly some sort of operational linkage between the western and Third World agencies would be to the benefit of all concerned.

### Third World News Agency - A Plan

The element of linkage is missing in an otherwise interesting plan for a new Third World News Agency (TWNA) presented to the 1977 Murrow Center Conference by Narinder Aggarwala. His concept was for an agency that would be "truly multinational in operations, management as well as staffing, free of domination--not only of the governments but also of any of the national news agencies." Aggarwala's outline calls for a more elaborate international mechanism than that of the present Non-aligned Pool. In addition to receiving the output of the various national agencies, the TWNA would have its own offices in major news centers such as New York, London, Paris, Moscow, Geneva, Peking, etc.

The present Non-aligned Pool is highly centralized; most participants send their contributions to the Yugoslav news agency TANJUG in Belgrade for relay on its radioteletype circuits to appropriate areas of the Third World. Aggarwala foresees three TWNA regional centers, each with multi-lingual translation capabilities. The regional center would receive dispatches from both the TWNA international bureaus and the various national agencies for appropriate relay. As a double check on the work of the national agencies, the regional centers of TWNA would have their own "national" bureaus in each country. National Bureau chiefs would be non-nationals of the country to which they were assigned, a precaution against the pressures that nationals are inevitably subjected to. "The (non-national) bureau chief will be one of the most important functionaries in the TWNA setup," Aggarwala wrote. "He/she will be responsible for building up the credibility of the TWNA as a news disseminator by weeding out unreliable or unverifiable material from national news agency dispatches."

Aggarwala would have the TWNA concentrate at first on serving the media of developing countries. "In that sense," he says, "it will not change the Third World coverage in the Western media. However, as the TWNA builds up its services and establishes its uniqueness, credibility and reliability as a news disseminator, it is likely to attract subscribers from the developed countries." He does not indicate either the source or the extent of the funds needed to turn the TWNA concept into a reality, but there can be no doubt it would require an investment much greater than the costs of the present Non-aligned pool.

Agency development within the Third World is uneven; and the basis for the functioning national agencies required for Aggarwala's TWNA concept may take time to evolve. Biola Olasope of the Nigerian Broadcasting Corporation indicated the extent of the problem in a paper presented to the Murrow Center Conference in 1977. Far from having correspondents in more distant power centers, he said, the few African countries with national news agencies "do not even have correspondents in other African countries...Lagos, the capital of Nigeria, is a major power center within the African context, but no African news agency maintains an office there at present. The reasons for this unsatisfactory situation are simple. African countries lack the funds, trained personnel and facilities needed for setting up and operating an international network for gathering and distributing news."

In any case Aggarwala's TWNA blueprint is there for consideration by the Third World. More within the realm of present possibility would be a joint venture by Third World and western media in a way that would utilize existing news collection and distribution facilities and provide, at far less expense to all concerned, a new dimension of Third World news on a basis of cooperation rather than competition.

## Proposal for a Multinational North-South News Agency

It is suggested that a joint study be made of the feasibility of forming what, for illustration's sake, will be referred to here as the Multinational News Agency, one which would represent a joint North-South venture in news collection and dissemination. Some possible guidelines for its organization and operation follow:

1. The purpose of the Multinational Agency would be to provide on a cooperative basis the type of news reportage now felt to be missing in the Third World. It would avoid day-to-day "hard" news, expecially concerning national or international politics, which is more properly the function of existing news sources. Instead, the Multinational Agency would place its emphasis on the projects and programs in the Third World for economic, cultural, industrial and social development. Its goal would be to supplement existing sources by reporting on activities that rarely make headlines but which are nevertheless of great interest in many places. It would strive to provide well-rounded reportage, that would neither ignore "problems" where they exist nor concentrate on problems to the exclusion of all else. On the basis of what is known of the news now coming out of the Third World, the Multinational Agency would seek to provide the missing dimensions.

2. Participants in the Multinational Agency would be drawn from among the membership of the Non-aligned News Pool on the one hand, and on the other, from press organizations represented directly or indirectly by the World Free Press Development Committee (i.e., the developed countries).

3. Interested elements from each grouping would organize the Multinational Agency around a 12-seat Directorate representing the press of the developing (South) and developed (North) worlds on an equal basis.

4. A beginning might be made with the participation of media representatives of the following countries: South - Egypt, India, Mexico, Kenya, Nigeria and the Philippines; North - Sweden, Japan, West Germany, United States, Britain and France.

5. Membership in the Directorate would be limited to professional journalists of the highest level. No country would be allowed more than one seat.

6. The Directorate would assemble a corps of special reporters for the Multinational Agency by asking, first, the principal news agencies, and second, the major newspapers of each grouping to loan it the services of one experienced correspondent for a fixed period, certainly not less than one year.

7. The salaries of correspondents seconded to the Multinational Agency would be paid by their regular employers as their contributions to the joint enterprise. Their expenses would similarly be underwritten until such time as the Directorate could obtain alternate financing. Since no agency or newspaper would be asked to provide more than a single correspondent, the cost for each participant would not be heavy.

8. For practical purposes, the Multinational Agency's staff could be limited at the outset to 8 to 10 correspondents from each of the two groupings, giving it a total corps of 16 to 20 seasoned correspondents--still an impressive number. The numbers could be increased as time goes on.

9. Because of their special role in the realm of international news, the Big Four western agencies would function as a permanent source of correspondents for the Northern side, as might West Germany's DPA and Japan's KYODO. Once agency members were recruited, the Staff to be provided by each side would be rounded out by requesting the loan of other correspondents from individual newspapers, always on the same economic basis.

10. Correspondents seconded to the Multinational Agency would work under journalistic supervision provided by the Directorate. Each correspondent would specialize in coverage of a given country or countries and would be based in one of those countries. In no event would a correspondent be assigned to his own country. The desired effect would be, for example, an Indian journalist covering a Nigerian event for the rest of the world, or a French journalist covering an Egyptian event.

11. Dispatches written by the correspondents would generally be airmailed to a central distribution office to be designated by the Directorate. The dispatches would be made available simultaneously to all participating agencies. Because of already existing exchange agreements among world agencies, these dispatches in this way would also reach TASS, HSINHUA, etc. and others not directly represented in the Multinational Agency.

12. The Big Four western agencies might provide use of their global communications facilities to correspondents of the Multinational Agency on those limited occasions when it was felt a dispatch could not await delivery by air.

13. The Multinational Agency would not affect the competitive operations of any established news agencies in any area. Since all would get the output of the Agency simultaneously, none would be disadvantaged by its operations.

14. Funds necessary to operate the Multinational Agency would be obtained by the Directorate from participating countries of both North and South. Limits might be set on the national contributions to prevent any domination of the operation. Contributors would raise funds in their own characteristic and preferred manner. Private, non-government monies would be preferred by some participants; for others, there would be no alternative to government monies.

15. The Directorate would select one of its members as Chairman. It would establish a headquarters office on the premises of an existing journalistic organization in some large Third World center where most major news agencies are represented. This would house the skeleton staff needed by the Multinational Agency itself.

16. The working staff of the Multinational Agency would consist of a Managing Director and three deputies chosen by the Directorate. They would be posted in the central office to direct the work of the special correspondents and ensure the widest possible distribution of their reportage.

17. For an initial period at least, the Multianational Agency would operate in English as the language most common among the participants. This would not and must not bar non-English-speaking journalists from being assigned to the Agency staff. In their case, dispatches would be sent first to their own home offices for translation before being forwarded in English to the Multinational Agency for general distribution.

18. Once established, the Multinational Agency could serve as a central clearing house or a natural bridge for other forms of cooperation between First and Third World journalists. The Directorate could be authorized to accept grants from governments as well as private sources to finance exchange programs and scholarships for training of journalists and sharing in technologies.

19. By its very nature, the Multinational Agency will itself provide an important training function which should help to eliminate what Third World critics frequently perceive as unconscious bias in western reporting on the developing countries. The day-to-day cooperation and consultation among members of the Directorate and its staff can result only in greater understanding of those deep-running differences of culture and language which more often than not are the true explanation of alleged bias. Moreover, the constant movement of correspondents of different nationalities in and out of dif-

ferent countries will foster cross-cultural transfers of knowledge and background and thereby produce increasingly perceptive and sophisticated reportage. As correspondents complete tours of duty with the Multinational Agency, they will take with them broadened cultural perspectives that can only make them better correspondents, no matter where they are next assigned by their regular employers.

20. In its commitment to fair and well-rounded journalism, the Multinational Agency would seek to promote the concept of open access to news in the international sphere, and to minimize obstacles to the movement of reporters across national boundaries.

What must now be determined is whether this basic concept is considered feasible by the potential participants. There are certain to be reservations and hesitations on both sides. The outline is admittedly limited in scope. And yet, the utter unlikelihood that any alternate global formula can be found, even in the remote future, would surely suggest that a solution by stages is the most realistic way to make a beginning.

What cannot be emphasized enough is that the Multinational Agency would in no way undercut, conflict with or otherwise affect the workings either of the Non-aligned Pool or any of the other agencies concerned. All would continue their regular activities in the ordinary way. The Multinational Agency would simply provide a limited superstructure that would do two things: (1) provide for the joint production of a dimension of news now widely acknowledged to be in short supply; and (2) provide a central point for other types of cooperation between important elements of North and South, including training programs, sharing of technical knowledge, and the solution of common problems on a cooperative basis.

The detailed mechanics for an enterprise of this type could be worked out without great difficulty if the basic idea were found acceptable. A vital requisite would be the acceptance, particularly by privately-owned western media, of the concept of mixed private and governmental funding. This is a point that must not be glossed over because it is crucial. Any Third World financial support of the Multinational Agency would of necessity come from national treasuries, since news agencies in developing countries are, without exception, dependent on official funding to some degree. This involvement by government with news media is more a matter of sheer necessity than of preference or ideology. The circulation and advertising bases needed for the operation of financially independent media simply do not exist in most of the Third World. Their real choice, therefore, is not between free media and government-controlled media, as some commentators seem to believe, but between government-controlled media and no media at all.

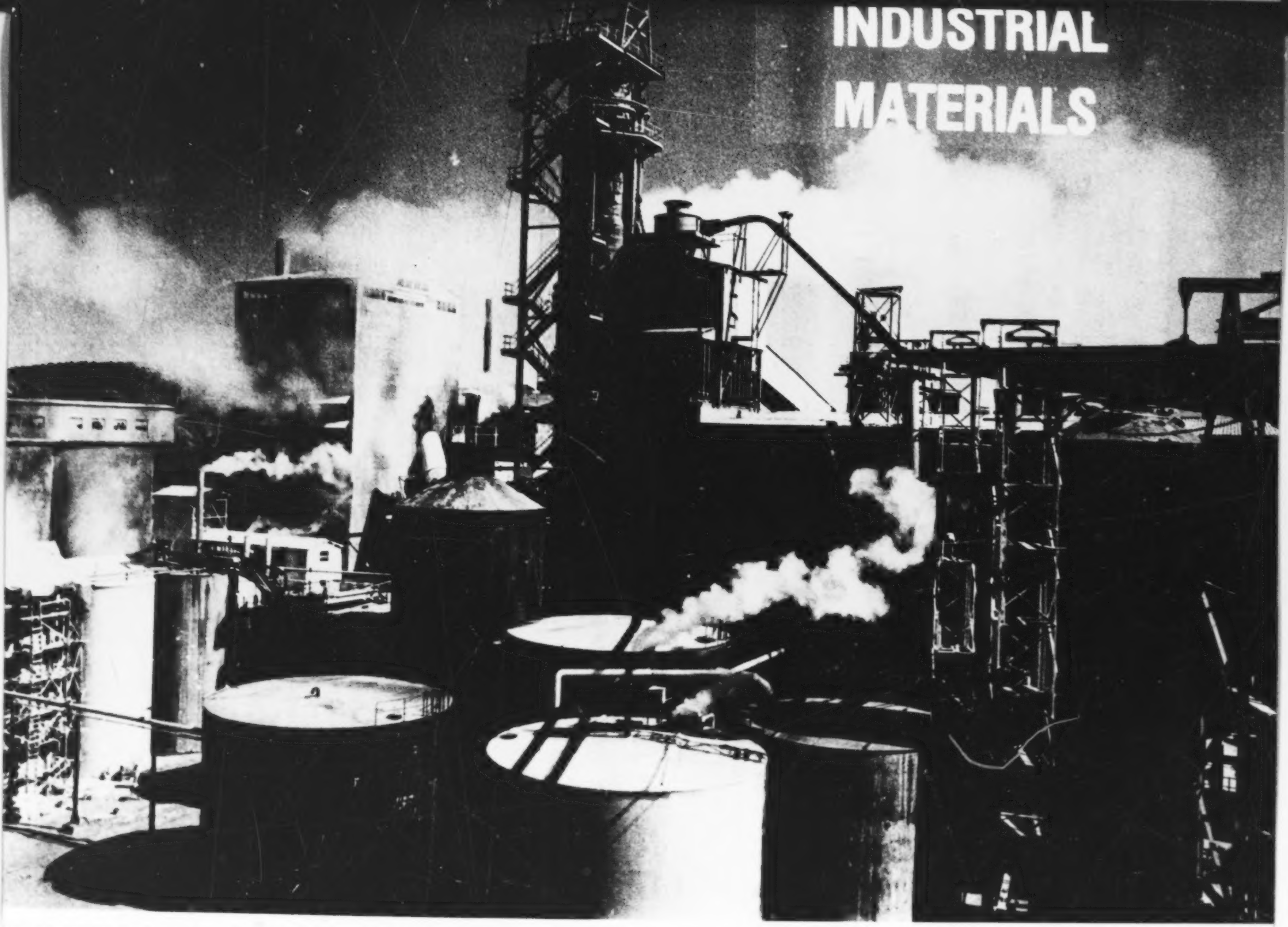
Those who issue blanket indictments of government involvement with news media anywhere, and under all circumstances, are in reality sentencing millions to indefinite periods of informational poverty. When there are no other options, a press founded and controlled by government surely is better than no press at all. As economies develop and literacy grows, such a press at least provides a base from which a more independent system can evolve. The cooperation of western media in something like the Multinational Agency would help encourage such a metamorphosis in places where there is still no irrevocable commitment to the Soviet model.

Inherent in the mixed nature of the Multinational Agency is the mechanism for allaying the historical fears of some western media, particularly the American, of any financial dealings with governments, especially their own. The intermingling of monies from all sources in a multinational treasury would preclude any basis for suggesting that any one participant was subsidized by any one government. Moreover, no official monies would go to any individual agency or newspaper. All would go directly to the Directorate for payment of the few headquarters salaries and, eventually, the expenses of the pool correspondents, whose salaries would continue to be borne by their employers.

This arrangement makes it possible for governments of developed as well as developing countries to contribute to the Multinational Agency, within limits which would be established by the Directorate to prevent financial domination by any one donor. The question of government finance is emphasized here because it is extremely unlikely that private initiatives such as that of the World Free Press Development Committee can alone mount or support a program that could have any real impact on the international flow of news. In any study of the feasibility of the Multinational Agency concept, the first question to be answered is whether this form of mixed funding is acceptable. If that problem can be overcome, the task of developing a more detailed blueprint for a Multinational Agency becomes immediately less difficult.

[Extracted from a paper prepared for a Conference on the International News Media and the Developing World, Cairo, April 1978, sponsored by Cairo University's Faculty of Mass Communication and the Middle East News Agency. Copyright © 1978 the Edward R. Murrow Center of Public Diplomacy of the Fletcher School of Law and Diplomacy, Tufts University, Medford, Mass. 02155. Reprinted as an Occasional Paper of the Murrow Center.]

# INDUSTRIAL MATERIALS



THE LAJA CHEMICAL
PULP PLANT NEAR
CONCEPTION, CHILE
(PHOTO: BY RAY WITLIN FOR
WORLD BANK AND IFC)

# Materials: Some Recent Trends and Issues

Hans H. Landsberg

[This article reviews briefly the arguments and the evidence on the probabilities of exhaustion of world materials supplies, and the prospective effectiveness of several ways of adapting to greater scarcities.]

Man has always been preoccupied over tomorrow's supplies. While immediate needs are perhaps less in question now, the dynamics of growth have enormously broadened the scope of concern. Once provisions of minimum food and shelter needs have been assured, growth has meant added ways of occupying one's time and most of these invove the use of *materials.* For this discussion, materials comprise basically the nonenergy minerals, forest products, fibers and those chemicals not already covered; excluded are food, energy sources and drugs. What we wear, move on and in, live, sit and lie in, use to fashion tools, simple and complex, or need for modern entertainment, recreation, education, and much of the healing arts, all this incorporates materials as defined.

## Depletion and Adequacy

The volume and variety of materials used in modern society have grown steadily. The rise in aggregate consumption has given birth to two ideas. One is the opinion that materials exhaustion could bring civilization tumbling down. The other is a rather widespread opinion that the advanced societies are "moving away from goods to services" and will continue to do so. A gradual reduction in the rate of growth of materials consumption, and eventually perhaps in consumption it-

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self, would follow. There is yet a third group of theorists who point to mankind's past success in overcoming the threat of scarcity as grounds for believing that we are neither threatened by exhaustion, nor must we seek salvation in a transition to a service-oriented economy. Instead, reliance is put on more efficient ways of gaining materials in conventional environments, of identifying new environments and new materials, and proceeding to more efficient use and reuse of materials.

The battle among these groups has swayed rather indecisively. The impact made by the *Limits to Growth* school (See Development Digest, October 1974, pp. 3-43) has been massive, especially in some European countries that have traditionally been materials-poor. Stripped of the moral and emotional overtones that often accompany the main theme there remains a core of insight to the warnings; this core deserves serious consideration when appropriately formulated. Brooks and Andrews point to the declining usefulness of distinguishing between renewable and nonrenewable (finite) resources. They caution, however, that the rub comes in managing the extraction and processing stages, because the effects of earth-moving and other disturbances of the environment present increasingly difficult and costly obstacles that can overwhelm the task of supplying rising quantities of desired materials, and may constitute the real limits to growth.

Companion arguments focus on the relative magnitude of the earth's unexplored and explored portions, on the ocean bed as a future technologically feasible supply base for at least half a dozen metals, and the known, very large occurrences of a few minerals--such as iron, aluminum-containing ores, silicates, carbon, titanium and magnesium--on which could be based, if not an exact replica of today's society, a reasonable variant thereof. While as yet little explored, the building of credible scenarios incorporating severe constraints with regard to the availability and variety of materials could usefully illuminate this particular issue, sometimes dubbed "the worst case" approach. The point is not to stress the fact that mankind once existed with a small fraction of our materials supply, so why couldn't we; but rather it is to inquire, knowing what we know now, to what extent, in what direction, and at what cost a greatly restricted materials menu would force us to modify our way of life.

A recent entry is the idea that, given sufficient low-cost energy, the materials problem tends to disappear as energy becomes a substitute. Consequently, the emphasis shifts to the limits set for energy consumption, by way of heat release or other accompanying circumstances of energy production and consumption, that counsel at least prudence.

By and large, the adequacy debate seems at a standoff. The *Limits to Growth* approach no doubt has increased our sensitivity to the depletion issue. At the same time, the bigger-than-life dimensions of the model have limited its usefulness to policy-makers and increased the number of objections based on its mechanistic framework and its neglect of important variables that could be assumed to be operating in the early portion of the time span of the *"Limits"* model. In contrast, no technological breakthroughs have occurred of the kind that would give the argument that depletion continues to be shifted forward in time a winning edge, nor has there been a breakthrough, for example, in seabed material recovery, or a switch to new abundant mineral resources in, say, the aluminum area, or in recovery methods, such as leaching as opposed to excavation. No wonder that proposals to engage in a systematic drilling exercise to "inventory" world resources have found some enthusiastic supporters, especially among geologists.

## Goods versus Services

Perhaps there is a way out if we are indeed slated to develop into a world where production of goods is rapidly giving way to production of services, as in the more industrialized countries. With demand diminishing, first in its rate of growth, then absolutely, the opportunities for clashes of competing objectives would equally diminish. It is, therefore, useful to review the nature of this phenomenon, sometimes referred to as the "post-industrial society." But the concept is somewhat at variance with the facts. To begin with, the so-called service industries are in part quite material-intensive: transportation and utilities are good examples. Consumer expenditures for services in the U.S. National Accounts (as opposed to service industries) involve heavy materials use, extending to such apparent nonmaterial categories as recreation, medical services, entertainment, and others as practiced in our society. To illustrate, a couple of years ago I sorted out the appropriate categories in the 1970 National Accounts. I found that, of an estimated $39 billion of consumer expenditures for recreation, fully 17 consisted of durable goods and 11 of nondurables, while only the remaining 11, or less than one-third of the total, were classified as "services" proper; even portions of this last category may in turn contain a quota of materials.

Nor, contrary to impressions sometimes gleaned in the media, has the U.S. gone very far in the "turn to services." Only when shifts in employment are considered do we find a significant trend to services: from 56 to 68 percent of total employment in the two decades ending in 1970 (a large part of this change reflecting the decline in agricultural and the growth in government employment, especially in education). In contrast, services grew only from 34 to 38 percent of total consumer expenditures during the same 20 years; and the share of the so-called service industries (a fuzzily defined category) went from 60 to 63 percent of the gross national product (GNP), corrected for inflation.

If the record of the past two decades renders it questionable to count on a reduction in the rates of the use of materials because the service sector will grow at the expense of the goods sector, this is not to say that such rates need to continue at their historic trend. There are other ways in which materials use may be reduced. Some authors like Malenbaum and Brooks have attempted--mostly for metals--to systematize this reduction by postulating materials-intensity factors that decline with rising per capita GNP. The idea is seductive, even though the statistics adduced lack a description of underlying process and motivations. Students of U.S. energy history are reminded of a parallel in which, over a period of some 100 years, the ratio of per capita energy use to per capita GNP first increased, then flattened out, and then declined. In the case of materials, this phase of research remains to be tackled.

In the absence of a common measure of materials use--other than a monetary unit--the thesis so far rests on historical trends and projections for single commodities. Substitution effects thus cannot be isolated. Over extended periods in which materials of petrochemical origin, for example, have risen with extreme rapidity, one would like to test the hypothesis for materials in the aggregate. Such an effort would assess, for example, whether a country passing through a heavy capital goods investment phase, including construction of major transportation networks, public facilities, and the like, is especially materials-intensive; it would examine how far improved efficiency in use plays a role, as economies mature; and whether, as suggested above, the trend is toward newer materials, imparting to the old standbys--such as iron, copper, lead and zinc--a downward momentum, which may be misread as a general "law." In the meantime, it is probably prudent not to look to the possible existence of such long-term relationships--an intensity rise and decline law--as offering a way out of contemporary problems associated with materials production and use.

## Materials Extenders

Recycling and substitution are the two "magic" terms that suggest more immediate escapes from scarcity, and are on everybody's agenda of remedies. Although neither is new, knowledge for judging the opportunities they offer is scant. Recycling has been given a new momentum. But at the same time, we have become aware of the obstacles to recycling or reuse, some of them institutional, some technological, and some economic, that is, cost-associated. Estimates of the potential contribution to the total materials supply by mobilizing after-use streams or stocks of materials depend on assumptions regarding the estimated length of the useful life of the product, efficiency of the gathering mechanisms, recovery efficiency, characteristics of the recovered material in relation to the specifics of demand, and public policies designed to affect the incentives for increasing efficiency all along the line.

As the result of an attempt a few years ago to judge what metals might raise the contribution made by scrap if there were an active recycling policy, it was estimated that little in the way of added material could be expected for iron and lead--that is, recycling mechanisms and incentives appear to be working effectively already--but somewhat more for copper, and a great deal more for zinc and aluminum. In the last instance, the relatively recent emergence of the material as a large tonnage item inevitably means that the volume should rise as stocks of obsolete products come increasingly into the market. Given the large energy component in primary aluminum and the relatively small one in the secondary product, the prospect of a rising recovery potential is cheering; but much depends on creating the slope that will enable the secondary material to slide into use rather than disposal. All this is in the future, however. The available statistics reveal no upswing in recycling up to now.

As for substitution, the upheaval in energy prices has upset the once widespread speculation that the more abundant minerals, like aluminum and magnesium, and those derived from oil and gas, would increasingly encroach upon their competitors. High energy costs of both are now an obstacle to expansion; and while their light weight gives them an advantage in some uses (for example, aluminum and plastics in motor vehicles), this must now be balanced against the demerit of a high energy input in their manufacture. Indeed, there has been occasional agitation for deliberately reversing the historical trend and substituting steel for aluminum, solely on the grounds that the former is less energy-intensive. Like most single-purpose policies, this one too suffers from the tunnel vision of its perpetrators. Very sophisticated and specific models would be required to decide which material has some over-all superiority in a societal sense; and social goals no less than private ones are bound to change with changing circumstances, and especially technology. On a more general plane, it requires that we refrain from subordinating or sacrificing total cost estimates to calculations cast only in physical terms.

A more recent suggestion designed to widen the materials horizon has been to consider substituting renewable--that is, biomaterials--for nonrenewable ones. Forest products, fibers, natural rubber, and others are said to merit a new look. The driving forces here are (i) the high price of energy in situations where the fossil fuels constitute the feedstock, supply the needed process heat, or both; (ii) the desire to ease the draft upon depletable minerals; and (iii) the thought that such a turn would be beneficial to some of the developing countries that have in the past lost their markets to synthetic substitutes for their natural products.

The suggestion, or set of issues, cannot be evaluated in any generally valid sense. At some level of cost it may indeed be cheaper to derive feedstocks for the chemical industry from trees or other plants rather than from natural gas, oil, or coal; or natural rubber may regain part of the market it has lost in the past three decades to the synthetic product. If and when such conditions arrive as a consequence of relative shifts in costs and prices, judgments will have to be made whether these changes are desirable also from other vantage points. Land devoted to growing industrial materials, for example, would not be available for raising food crops. In order to increase productivity, fertilization would have to be greatly increased. Environmental problems are bound to emerge at various processing stages. While one ought to be alert to the opportunities offered by moving along this particular substitution route, comprehensive analysis is in order before facile hypotheses turn into conventional wisdom. It is perhaps worth stressing that forest land is likely to be eyed as potential cropland, as "energy farmland" to produce combustible timber, and as a source of chemical feedstock, quite apart from the traditional growing of timber for forest products. Multiple claims will have to be sorted out and reconciled.

[Extracted from Science, Vol. 191, No. 4227, February 20, 1976, pp. 637-9. Copyright © the American Association for the Advancement of Science, Washington, D.C.]

# Energy Implications of Materials Processing

Earl T. Hayes

[The energy used up in the processes of converting materials into forms used by consumers or industry (including also energy materials themselves) is very large, and becomes increasingly important as energy costs go up. This kind of analysis, which is relatively new, is shown for the United States; similar relationships and considerations are involved in assessing the situations in other countries.]

Industrialization can be defined as substituting fuel energy for human energy. Chemical engineers have traditionally performed materials and energy balances in their research. Such balances are needed today, as never before, because our accounting for energy consumption must go far beyond knowing that the steel industry consumes 5 percent of a nation's total energy supply, or that to produce one pound of aluminum requires 6 to 8 kilowatt-hours of electricity in the smelting step. Today, energy accounting must be precise and sophisticated, and it must include metallic and industrial minerals, plastics, chemicals, and fuel minerals. The efforts of industry to extract these materials from nature and convert them to useful states requires more than one-fifth of the total U.S. energy budget, for example.

## General Approach

The definition of materials used in this article includes fuels as well as structural materials. Thus, in the analysis of amounts of energy required to produce usable substances, the energy, materials, and dollar equivalents are involved. Rigorous analyses of materials processing systems to determine unit energy

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requirements were not done systematically until the last few years. Such evaluations of metals, chemicals, and other commodities are just now coming into the scientific literature.

Each material requires its own analysis development under some broad guidelines. In one methodology, any specific materials analysis covering a commodity must be large enough to include the entire industry of any nation. All degrees of technological progress must be represented in the final output figures. Modern facilities must be taken together with outmoded plants, and their energy efficiencies averaged. For example, zinc recovery systems vary in efficiency from 60 to 85 percent; all operating levels must be included.

Both upper and lower bounds limit energy analysis. In the last 4 years the United States consumed 69 to 73 quads (1 quad = $10^{15}$ Btu's) annually, and the total energy estimated in particular uses cannot exceed this figure. Data from the Bureau of Census and the Bureau of Mines provide more refined summaries of the total energy expended by specific industries; these values are upper limits for the particular industries. Lower limits include for example, the energy used in the construction of a grinding mill, or the calorific value of human labor. Such data are insignificant in overall energy studies dealing with tens of millions of Btu's per ton of material.

Society must know the energy requirements of all industrial materials for many purposes. The most important are for determining (i) the energy intensiveness of specific materials, (ii) the national requirements for specific materials industries, and (iii) energy flow diagrams paralleling process flow diagrams. These factors help guide the selection of materials. Further, they aid those seeking to conserve energy in present systems and to minimize energy requirements in developing new technologies.

## Metallic Materials

Several studies on metals have appeared in the last few years: for example, the Battelle Columbus Laboratories performed a complete evaluation of energy in materials for the Bureau of Mines. Battelle employed basic metallurgical flow sheets, starting with ore in the ground and proceeding through the steps of mining, transportation, concentration, and reduction to the metallic ingot stage. They then assigned energy consuption rates to each step in the flow sheets. Census data, Bureau of Mines surveys of industrial consumption and production of energy, information on industrial operating experience from several sources, and other published information provided the basic energy data. In the Battelle study all energy inputs were converted to a common factor, British thermal units; a value of 10,500 Btu's (thermal) per kilowatt-hour was used for electricity.

Two metals, copper and iron, are of particular interest because of their significance to society. Copper is important because it is such a good conductor of electricity and heat; these properties are essential in an industrialized society. Iron and its alloys are the most versatile metallic materials available to man and are produced in the largest amounts. Without copper and iron no economy could hope to meet the demands of the people.

A simplified flow sheet for processing 1 ton of copper from a sulfide ore containing 0.7 percent copper (near the current average grade) appears below. The average energy consumed in each step, expressed in millions of Btu's, appears in parentheses. The accuracy of the total energy was estimated to be ± 10 percent.

Mining (21.6)
↓
Concentration (42.3)
↓
Smelting (38.2)
↓
Refining (10.2)
↓
Total: Refined copper (112.3)

Some copper is recovered by leaching heaps and waste dumps with sulphuric acid. The process precipitates the copper from solution, electrochemically, with ferrous scrap. A separate flow sheet developed for that segment of the industry shows the energy ($10^6$ Btu's) needed to produce 1 ton of cement copper.

Sulfuric acid solution
(largely self-generated)
↓
Pumps (41)
↓
Waste dumps (0)
↓
Precipitation (45)
(2 1/2 tons detinned steel cans)
↓
Total: Cement copper (86)

Copper requires between 86 and 112 million Btu/ton. This high energy consumption stems from problems associated with the relatively low grade of the ore. Iron and steel require far less energy per ton of material produced. The flow sheet developed for the production of steel slabs appear as follows, beginning with the traditional open-hearth furnace approach.

Blast furnace (17.4)
↓
Open-hearth furnace (6.1)
↓
Ingot casting (0.74)
↓
Slabbing mill (1.9)
↓
Total: Steel slabs (26.1)

The basic oxygen furnace consumes slightly more energy than an open-hearth furnace because less scrap (and more hot pig iron) is used. The energy flow sheet shows 21.8 x $10^6$ Btu/ton for the blast furnace and 2.8 x $10^6$ Btu/ton for the basic oxygen refining operation, giving a total of 27.2 million Btu/ton.

The third steel process, the electric furnace, uses a 100 percent scrap feed. The energy flow sheet appears as follows

Scrap (0)
↓
Electric arc furnace (10.0)
↓
Ingot casting (0.74)
↓
Slabbing mill (1.9)
↓
Total: Steel slabs (12.6)

for a total of 12.6 x $10^6$ Btu/ton. This low figure for steel from scrap represents a subsidy from the original blast furnace reduction of material making up the scrap. Note that in this case the iron is available for further recycling, whereas in cement copper the metal was consumed and therefore an energy charge. It is also a graphic demonstration of the importance of recycling.

The energy used by ten metal industries is summarized in Table 1. These ten metals accounted for 5.45 quads of the estimated total of 5.8 quads used by the primary metals industry in 1973, almost 8 percent of the country's total energy consumption. A minor amount of energy was imported in the form of bauxite, iron pellets, chromite, and other raw materials. For purposes of uniformity, however, the study assumed that all materials processing occurs in the United States. Energy imports are offset by energy exports in the form of finished products.

An important factor to be considered is the energy expenditures associated with using plentiful domestic resources of lower-grade ores. Bravard *et al.* calculated the added energy required for producing five metals from lower-grade ores. In the case of aluminum,

## TABLE 1

### Energy requirements for selected metals in the United States in 1973

| Commodity | Product | Energy required<br>Per net ton product ($10^6$ Btu's) | <br>Total ($10^{12}$ Btu's) |
|---|---|---|---|
| Iron and steel | Steel slabs | 24 | 3350 |
|  | Gray iron castings | 34 | 366 |
|  | Carbon steel castings | 42 | 54 |
| Aluminum | Ingot | 244 | 1170* |
| Zinc | Ingot | 65 | 92 |
| Lead | Ingot | 27 | 23.9 |
| Copper | Cement copper | 87 | 14.9 |
|  | Refined copper | 112 | 221 |
| Chromium | High-carbon ferroalloy | 61 | 15.8 |
|  | Low-carbon ferroalloy | 129 | 19.5 |
| Magnesium | Metal | 358 | 42.0 |
| Manganese | Ferromanganese | 49.5 | 33.0 |
|  | Blast furnace | 46 | 17 |
|  | Electric furnace | 52 | 16 |
| Titanium | Metal | 408 | 8.2 |
| Uranium | Uranium oxide |  |  |
|  | Acid circuit | 776 | 2.1 |
|  | Alkaline circuit | 1123 | 2.2 |
|  | Resin-in-pulp | 795 | 2.3 |

*In practice, 40 percent of aluminum electrical energy in the United States is derived from hydroelectric plants. The figure 244 × $10^6$ Btu/ton in the Battelle report is reduced to 204 × $10^6$ Btu/ton in calculating total U.S. use of 1.17 quads.

lower-grade bauxite or clays would be favored over anorthosite for long-term development, the processing costs being nearly equal. The problems associated with processing lower-grade ores are due to the increased volume of material, which requires higher energy inputs for mining and transportation and a greater percentage of the total energy to be used in crushing and grining. Kellogg concluded that the most important element is the grade of ore. This is demonstrated in Table 2, taken from unit studies of the Battelle report.

## TABLE 2

### Energy expenditures in mining and concentrating selected metallic ores

| Commodity | Grade (%) | Tons ore per ton metal | Energy per ton product ($10^6$ Btu's)<br>Mining | <br>Concentration | Percentage of total product energy |
|---|---|---|---|---|---|
| Iron | 30 | 4 | 0.61* | 2.0 | 11† |
| Zinc | 10‡ | 12 | 5.3 | 5.2 | 7 |
| Lead | 10‡ | 12 | 4.3 | 4.5 | 30 |
| Copper | 0.7 | 157 | 21.6*† | 42.3 | 57 |
| Uranium | 0.2 | 530 | 332.4* | 246.6 | 58 |

*Surface mining. †Pellets. ‡Estimated.

The results given in Table 2 can only be considered indicative. For instance, 36 percent of uranium is mined underground, and the mining energy for that portion would be several times higher than the energy for surface mining. The general trend is shown by the rising energy costs of mining lower-grade nonferrous ores. It is only the increased use of energy through mechanization that has made mining of such ores economically possible. Lovering estimated that while U.S. mineral production rose 50 percent in the last 50 years, energy consumption went up 600 percent in the last 25 years.

There are three ways to counter this: (i) using better technology, such as a cheaper grinding process or *in situ* leaching; (ii) recycling, which uses 50 to 30 percent of the energy required to produce metals from ores; and (iii) making better use of the metals we produce--for example, doubling the life of an automobile.

## Nonmetallic Materials

The nonmetallic sector consumed 1.9 percent of the total U.S. energy in 1973, and half of this was in Portland cement production alone. Some of the largest users in this class are shown in Table 3. As a class, nonmetallics are much lower in energy intensiveness per ton than metallic materials. This is because they are much more common in nature, and they are generally processed "as is" without reduction of oxides or silicates or breaking of chemical bonds. However, they are highly transportation sensitive. Truck transportation of sand and gravel, for an average of 20 miles, uses more energy nationally than the magnesium industry. Thus, materials can be energy intensive like titanium, with a high energy requirement per ton, or they can be low like cement, but the national aggregate is substantial.

TABLE 3

Energy requirements for selected nonmetallic materials for primary products in the United States in 1973

| Commodity | Product | Energy required<br>Per net ton product ($10^6$ Btu's) | <br>Total ($10^{12}$ Btu's) |
|---|---|---|---|
| Calcium | Quicklime | 8.5 | 182 |
| Cement | Portland cement | 7.6 | 688 |
| Ceramics | Common brick | 3.5 | 62 |
| Glass | Glass containers | 17.4 | 216 |
| Refractories | Basic brick | 27 | 18.2 |
| | Fireclay brick | 4.2 | 6.9 |
| Clays | Kaolin | 2.8 | 14.3 |
| Gypsum | Other clays | 0.1-5.3 | 16.7 |
| | Calcined gypsum | 1.5 | 19 |
| Sand and gravel | Sand and gravel | 0.056 | 53 |
| | | | 1276.1 |

## Energy Costs of Fuels and Electricity

A national energy accountability system also requires knowledge about energy inputs to such industries as coal mining, petroleum refining, and natural gas transmission. Adding their processing costs to the thermal value of the fuels produces total energy costs. In its own right, the extraction, conversion, and transportation of energy is the most energy-consuming sector of the American industrial scene. More than 20 percent of the gross energy of fuels is consumed in bringing energy to the materials processor. In practice, as described in this article it is necessary to start with gross energy in arriving at energy costs per unit of material and, in effect, assign all these energy losses to specific materials. The energy unit costs of petroleum, natural gas, coal and electricity will only be covered in general terms.

Coal production involves relatively low extraction and transportation losses per ton. Capital, materials, and equipment, estimated at 2 percent of the fuel value, would represent 500,000 Btu/ton. The Bureau of Mines estimates that in 1973 it required 31,300 Btu's to mine and prepare a ton of coal for market. It is estimated that the transportation energy is 330,000 Btu/ton--a total of 861,000 Btu/ton of delivered coal.

Petroleum is not such a simple case. Capital and equipment costs probably represent 2 percent of the fuel value. The extraction fuel value would add another 2 percent. Transportation by pipeline and tanker to a refinery also represents about 2 percent of the crude energy value. The refining operation itself uses tremendous amounts of petroleum fuels, natural gas, and electricity, which translate to more than 700,000 Btu's per barrel of crude oil. This amounts to 11 percent of the total energy to refineries, counting both crude oil and auxiliary fuels. On a national scale, it amounted to 2.83 quads in 1968 or 4.7 percent of the total energy of the United States. Thus, the petroleum industry consumes about 17 percent of its own energy equivalent in going from exploration to distribution of refined products.

In the United States 3 percent of all natural gas is used as transportation fuel for pumping gas from well to consumer. Equivalents of fuel used in extraction probably account for 2 percent. Other energy costs represented by equipment and capital are also estimated at 2 percent, so that 93 percent of the fuel value is delivered.

The energy costs of bringing fossil fuels to market are shown in Table 4. In energy accountability this shrinkage is assigned to specific classifications such as extraction, petroleum refining and transportation.

TABLE 4

Energy costs of bringing fossil fuels to market

| Commodity | Energy used | |
|---|---|---|
| | Percent | Btu's per $10^6$ Btu's |
| Coal | 3 | 30,000 |
| Petroleum | 6 | 60,000 |
| Petroleum refining | 11 | 110,000 |
| Natural gas | 7 | 70,000 |

Electricity, a secondary energy form, is far and away the most expensive in terms of energy costs. Yet, it is the fastest-growing sector. Some two-thirds of the input energy of the fossil (as well as nuclear) fuel used in electric power generation is dissipated, either in its transmission to the user or up the smokestack and down the river in the cooling water. In 1971 the United States consumed 25 percent of its gross fuel inputs to produce electricity. It used a gross of 17.4 quads, and "lost" the greater part of 11.9 quads in the production and transmission processes (some small fraction of the waste heat was used). In comparisons of energy per unit of output, the conversion of electrical energy has to take this loss into account. Theoretically, the conversion of 1 kilowatt-hour of electricity provides 3413 Btu's, but more than three times that much thermal energy is needed to generate and transmit that much electricity. A figure of 10,400 Btu's (thermal) based on actual industry measurement is generally used in this country. This figure has come down from a rate of 15,600 Btu's per kilowatt-hour in 1947.

In summary, the energy inputs of fuels for materials processing in the United States in 1971 were 12.56 quads for coal, 30.49 for petroleum, 22.73 for natural gas, 2.80 for hydroelectric power, and 0.41 for nuclear power--a total of 69 quads. Prorating electricity conversion losses and subtracting 5.7 percent for nonfuel uses (feedstocks, lubricating oils, and road materials) gives a net energy output of 57 quads.

## Energy Costs of Plastics and Chemicals

More than 90 percent of the feedstock of fuel and petroleum products in the United States is used in a half-dozen chemical industries. Gross energy inputs can be measured, as well as energy contained in the primary products. Past this point, the distribution or determination of energy per unit material becomes stickier. For instance, ethylene accounts for not only its own feedstock requirements, but also those of ethylene oxide, ethylene glycol, and, in part, ethylbenzene and styrene. It is beyond the scope of this article to trace out allocations of energy below the primary processing step.

The industrial use of energy for 37 selected chemicals in six Standard Industrial Classifications (SIC's) in 1973 is shown in Table 5. The total represents 4.8 percent of all U.S. energy in that year. The six largest energy consumers in this group are shown in Table 6.

TABLE 5

Energy requirements of six SIC groups in 1973.
(Numbers in parentheses identify SIC groups)

| Industry | Energy ($10^{12}$ Btu's) | | |
|---|---|---|---|
| | Process | Feedstock | Total |
| Alkalies and chlorine (2812) | 475.8 | 0 | 475.8 |
| Industrial gases (2813) | 110.5 | 48.9 | 159.4 |
| Inorganic pigments (2816) | 35.1 | 0 | 35.1 |
| Industrial inorganics (2819) | 442.5 | 345.6 | 788.1 |
| Cyclic intermediates (2815) | 70.1 | 158.7 | 228.8 |
| Industrial organics (2818) | 556.9 | 1273.5 | 1830.4 |
| Total (281) | 1690.9 | 1826.7 | 3517.6 |

The phenomenal growth of the plastics industry merits special attention. The process energy requirements range from 45-70 million Btu/ton for polystyrene to 135 Btu/ton for low-density polyethylene. The plastics produced in the United States in 1973, estimated at 14 million tons, required 1.4 quads of process energy, making plastics a larger consumer than the aluminum industry. The stored energy in the finished plastic is roughly equivalent to the hydrocarbon input and requires a raw material input of 0.6 to 0.8 quad. The only way to recover this energy is by combustion. This demonstrates that the plastics industry is one of the largest users of materials processing energy. However, unlike scrap metal, the material discarded by consumers can only be recycled as a fuel because of the present limitations of resource recovery technology.

## Implications

Processing of many materials could become energy-limited rather than resource-limited. The methods required to provide metals, industrial minerals, and energy fuels and materials in useful forms all consume significant quantities of coal, oil, gas and electricity. The materials industries use more than 20 percent of the nation's energy in processing

## TABLE 6

Six largest users of energy in SIC group 281 in 1973. Only feedstocks not accounted for by one of the other selected chemicals are included. For example, benzene is charged against styrene while ethylene is not.

| Chemical | Tonnage ($10^9$ pounds) | Energy consumption ($10^{12}$ Btu's) | | |
|---|---|---|---|---|
| | | Process | Feedstock | Total |
| Ethylene (2818) | 33.4 | 382.3 | 1078.0 | 1460.3 |
| Ammonia (2819) | 30.3 | 271.7 | 345.6 | 617.3 |
| Chlorine (2812) | 19.2 | 398.6 | 0 | 398.6 |
| Styrene (2815) | 6.0 | 51.1 | 86.6 | 137.7 |
| Methanol (2818) | 7.04 | 34.3 | 91.7 | 126.0 |
| Acetylene (2813) | 0.58 | 8.27 | 38.8 | 47.1 |

metals (8 percent), chemicals and allied products (7.8 percent), petroleum refining (4 percent), and nonmetallics (2 percent). Steel, aluminum, plastics, cement, and gasoline account for half of this. The issue becomes complex when one considers that each material has its own level of energy intensiveness and that there are ways in which energy can be lost or saved in the total economic system. Despite those problems, certain broad implications emerge for metallic, nonmetallic, and energy materials.

The data available for metallic minerals are the best defined, and their significance in the economy carries a clear requirement that energy intensity be considered in planning for their extraction and usage. Within that context, it becomes tempting to oversimplify the problem. For example, some 25 x $10^6$ Btu's are needed to produce a ton of steel and 245 x $10^6$ Btu's to produce a ton of aluminum. Thus, energy accounting might appear to mandate use of steel in preference to aluminum. But a ton of steel occupies one-third the volume of a ton of aluminum, so that substituting aluminum would greatly lower the energy savings per volume of material used. Further, for goods that are transported or used in transportation, lighter-weight materials provide additional energy savings. The same reasoning applies to plastics. Thus, energy accounting cannot provide as simple an answer as might be assumed from the initial data.

One clear planning precept does emerge, however. Each material has a fixed lower bound of ore grade, below which energy costs make processing uneconomic. The energy costs rise rapidly as ore grade decreases. At some lower limit, say 0.25 percent, the energy expenditures dominate the whole recovery picture. Technological improvements in rock disintegration, transportation, and concentration will have to be made if such low-grade ores are to be considered as reserves--that is, resources that can be processed economically.

In the case of energy materials, both extraction and refining have serious energy implications for the economy. As extraction becomes more difficult, and as more refining takes place, more energy is lost. For example, two-thirds as much oil as has ever been found is still in the pores of the host rock. One of nature's contributions to oil extraction has been the pressure of the accompanying natural gas, which forces petroleum through pores to collection centers of drilled wells. Most secondary methods of recovery involve pumping of various chemicals and fluids to force out the oil. The pumping energy alone places finite limits on the amount of total petroleum eventually recovered from different reservoirs. Also, more energy is used today in the search for oil--40 years ago 275 barrels of oil were found per foot of hole drilled; the comparable figure today is on the order of 25 barrels.

The refining of petroleum presents one example of energy losses incurred in making a fuel more useful. Conversion of solid coal into more useful products by gasification or liquifaction presents another example. About 10 to 20 percent of coal energy is expended in making a low-Btu gas (170 Btu's per cubic foot) and another 15 to 25 percent is used in upgrading it to pipeline quality gas (1000 Btu's per cubic foot). Electricity, the most ubiquitous and concentrated energy form, offers the ultimate example of energy losses incurred in a refining process.

The interweaving of energy losses in metallic and energy-mineral processing can be dealt with, but only through a total systems analysis. Such analysis, of true energy costs and possible real energy savings, is required if industry is to meet society's demand for materials in a world where energy, in all forms, is becoming increasingly expensive.

[Extracted from Science, Vol. 191, No. 4227, February 20, 1976, pp. 661-5. Copyright © the American Association for the Advancement of Science, Washington, D.C.]

# Limits to Exploitation of Nonrenewable Resources

Earl Cook

[The limits to the world supply of resources--that is, of materials which may be extracted and put to use at a cost which does not exceed their value in use--are not only a matter of their presence in the earth's surface but of the costs of processing. These will change with technology; but the possibilities for cost reduction by new techniques are not infinite.]

Nonrenewable resources consist of geochemical concentrations of naturally occurring elements and compounds that can or may be exploited at a profit. The concentrations that are at present exploitable at a profit range from slightly more than twice to several thousand times the average crustal abundance of the desired element (Table 1). Rates of concentration into ore bodies or oil pools appear to be slow compared to the pace of human history. Moreover, the formation of deposits of ores and mineral fuels appears to require unusual or extraordinary geologic conditions; consequently, such deposits are unevenly distributed in space and time, and they commonly occupy very small portions of the earth materials in which they are found.

Almost 70 percent of proved crude-oil reserves are in the Middle East, and five countries produce more than 65 percent of the world's copper. These nonuniform distributions are real and do not merely reflect differences in exploration effort. Many of the most common ore deposits appear genetically and spatially related to the boundaries of "plates" moving on the earth's surface. Other ore deposits may be localized by uplift of the crust over thermal plumes. Pet-

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roleum as well as metallogenic provinces exist, and the world's coal deposits are strikingly concentrated in the temperate belt of the Northern Hemisphere.

TABLE I

Ratio of Cutoff Grade (the lowest concentration economically recoverable in 1975) to Crustal Abundance (average amount of the element found in the materials of the earth's surface)
Values are parts per million (ppm)

| Element | Crustal abundance (ppm) | Cutoff grade (ppm) | Ratio |
|---|---|---|---|
| Mercury | 0.089 | 1,000 | 11,200 |
| Tungsten | 1.1 | 4,500 | 4,000 |
| Lead | 12 | 40,000 | 3,300 |
| Chromium | 110 | 230,000 | 2,100 |
| Tin | 1.7 | 3,500 | 2,000 |
| Silver | 0.075 | 100 | 1,330 |
| Gold | 0.0035 | 3.5 | 1,000 |
| Molybdenum | 1.3 | 1,000 | 770 |
| Zinc | 94 | 35,000 | 370 |
| Uranium | 1.7 | 700 | 350 |
| Carbon | 320 | 100,000 | 310 |
| Lithium | 21 | 5,000 | 240 |
| Manganese | 1,300 | 250,000 | 190 |
| Nickel | 89 | 9,000 | 100 |
| Cobalt | 25 | 2,000 | 80 |
| Phosphorus | 1,200 | 88,000 | 70 |
| Copper | 63 | 3,500 | 56 |
| Titanium | 6,400 | 100,000 | 16 |
| Iron | 58,000 | 200,000 | 3.4 |
| Aluminum | 83,000 | 185,000 | 2.2 |

Not only are geologic resources distributed unevenly over the surface of the globe, they are concentrated in the outermost part of the earth's continental crust. Mechanisms that concentrate chemical elements operate most effectively on and near the earth's surface: weathering, erosion, sorting during transport, groundwater leaching, and supergene enrichment are effective only in the upper few hundred meters of the continents. Hot metal-bearing solutions encounter the precipitating effect of colder meteoric waters and find relatively high permeability only in the upper few thousand meters of the earth's crust. Oil and gas formation, migration, and entrapment take place within the thin and discontinuous sedimentary skin of the continents. There is a hoary myth among old prospectors that ore bodies widen and get richer downward. In fact, they generally do just the opposite. The rich gold and silver deposits of the American cordillera are notorious for bottoming at depths of a few tens to a thousand meters. The world's greatest oil well, Cerro Azul No. 4 in Mexico, after producing more than 40 million barrels of oil, suddenly produced only salt water.

The limited nature of individual deposits, the difficulty of seeing through rock, and the history of many mining districts and oil fields have led to many forecasts of depletion and exhaustion. But, as old deposits have become exhausted and new one have become harder to find, world mineral and fossil-fuel production paradoxically has continued to increase. There is a wide difference of opinion now on the question of limits to the exploitation of nonrenewable resources.

## Three Kinds of Limits

To the mining or petroleum engineer, the profit of exploitation is defined by the difference between the price received for his product and the pecuniary costs of recovering the natural material and turning it into a salable product. To society, however, the profit from mining (including oil and gas extraction) can be defined either as an energy surplus, as from the exploitation of fossil and nuclear fuel deposits, or as a work saving, as in the lessened expenditure of human energy and time when steel is used in place of wood in tools and structures. In this context, the exploitation of earth resources for display, adornment, or monetary backing is a deficit operation, financed by energy profits from other kinds of mining.

The ultimate limit to exploitation of earth resources then is the limit of net energy profit (or work savings). When it takes more energy to find, recover, process, and transport the fossil fuels than can be gotten from them in useful form, there will be no more oil, gas, or coal resources. When it takes so much energy or work to produce a nonenergy material that one must sacrifice other, more needed items or services to pay for it, there will be no more resources of that material. Short of this energetic limit, one or both of two other limits may intervene. First is the limit of comparable utility. A resource is a resource only while it can be used to perform a function desired by man better or more cheaply than can another substance. If the energy cost of an earth resource such as crude oil rises to a level at which another substance, such as synthetic crude oil from coal, can be substituted in adequate volume at a lower cost for comparable utility, substitution will take place, with the first resource reverting to a mere geochemical anomaly and the source of the replacing substance becoming a resource.

The limit to a resource also may be determined by the unwillingness of society to pay the cost of its exploitation, even though an energy surplus (or saving) might be obtained thereby. Many primitive societies have preferred to take their energy surplus in leisure rather than in goods (stored energy or work) and deliberately abstained from exploiting available potential resources that could have increased their surplus. Some primitive agricultural societies still do this. A modern decision to forgo the calculable energy benefits of the breeder-reactor power plant would again invoke this limit of living-level degradation, a limit that comes into play when a society is not willing to pay the total costs of production because so doing would, it is judged, lower the level of living more than would forgoing use of the resource.

## Effects of Technology and Cheap Energy

To some, the history of nonrenewable resource exploitation seems to contradict the idea of an energetic limit short of mining common rock and "burning" seawater. During the past 150 years large increases in the earth-resource base of industrialized society have been attained. By increasing the efficiencies of discovery, recovery, processing, and application of such resources, we have been able to find and exploit leaner, deeper, and more remote deposits. By discovering and developing new methods of utilizing previously worthless materials we have created resources where none existed. Important in this rapid technologic advance has been a progressive lowering of the cost of energy per unit of work, or of useful heat obtained. Cheaper energy, along with technological ingenuity and discovery, have greatly extended the availability of nonenergy resources. In 1900 the lowest grade of copper ore economically minable was about 3 percent; today the economic cutoff has fallen to about 0.35 percent. At that grade each ton of refined copper produced requires the breaking, transport, and milling of almost 300 tons of rock and, in addition, the removal of perhaps an equal amount of waste or barren rock. A great deal of energy--about 26,000 kilowatt hours, the equivalent of the energy in about 4 metric tons of Wyoming coal--is required to produce a metric ton of copper today, but the cost of that energy is still low compared to the cost of supporting the equivalent in men and mules.

Many past forecasts of the exhaustion of one or more earth resources have come to appear almost wildly inaccurate in the light of later production. Forty years ago, geologist C. K. Leith, for example, called attention to the coming exhaustion of U.S. mineral resources, claiming that "despite a magnificent endowment [of metals and fuels], depletion is further advanced than even mining men generally realize." At the time Leith wrote, proved reserves of crude oil, zinc and lead in the United States were 15 to 20 times the annual production rates, the Lake Superior iron ores appeared to have less than 20 years of measured supply remaining, and known copper reserves were about 40 times the 1934 production. Leith went on: "Further discovery and the use of lower grade resources will extend the life of most of these resources, but the range of possibilities is now pretty well understood, and with maximum allowance for such extension, the figures are sufficiently small, when compared with what we hope will be the life of the nation, as to be matters of public concern... Discovery has not stopped, but the rate has been slowing... Of 33 metal-mining districts that have yielded the greatest wealth to date only 5 have been discovered since 1900 and none at all since 1907... The rate of discovery of oil and gas continues high...but the chances of finding another East Texas or Kettleman Hills are not promising."

Well, what happened? Since 1935, the United States has produced more zinc that it did before that year. In 1974 the U.S. mine production of zinc (Table 2) could have been maintained for 61 years on the then-known reserves. The ratio of domestic reserves to primary consumption, defined as domestic production plus imports minus the recycled or second supply, stood at 24 (see last column of table) although demand had soared. U.S. lead production since 1935 does not equal the pre-1936 total, but the ratio of measured reserves to primary consumption in 1974 was 67, and the 1974 mine production could have continued for 87 years without further discovery.

TABLE 2

COMPARISON OF THE RATIO OF UNITED STATES RESERVES
TO PRODUCTION (R/P) IN 1934 WITH THE
SAME RATIO AND THE RATIO OF RESERVES TO PRIMARY CONSUMPTION
(R/Cp) IN 1974 FOR FIVE MAJOR EARTH RESOURCES

| Resource | 1934 R/P (approximate) | 1974 R/P | 1974 Domestic mine (well) production | 1974 Net imports (primary and secondary) | 1974 Domestic secondary supply | 1974 Domestic reserves R | 1974 Domestic primary consumption (Cp) | 1974 R/Cp |
|---|---|---|---|---|---|---|---|---|
| Copper[1] | 40 | 57 | 1,441 | 391 | 455 | 81,800 | 1,640 | 50 |
| Iron Ore[1] | 18 | 24 | 83,000 | 46,000 | NA* | 2,000,000 | 140,500 | 14 |
| Lead[1] | 15-20 | 87 | 615 | 82 | 564 | 53,600 | 800 | 67 |
| Zinc[1] | 15-20 | 61 | 447 | 655 | 77 | 27,300 | 1,150 | 24 |
| Crude oil[2] | 15-20 | 11.3 | 3,043 | 1,268 | NA* | 34,250 | 4,447 | 7.7 |

*NA, not applicable.
1 in metric tons; source U.S. Bureau of Mines.
2 in millions of barrels; various sources

The Lake Superior iron ore of Leith's day has been virtually exhausted, but it has been largely replaced by taconite, a low-grade iron-bearing rock not considered to be ore in 1935. The 1974 ratio of measured reserves to U.S. iron-ore consumption was 14, and at the 1974 rate of U.S. mine production the reserves would last about 24 years. Since 1935, more copper has been mined in the United States than before. Based on 1974 figures, the ratio of reserves to primary consumption was 50, and U.S. mine production could have continued at the 1974 level of 57 years without new discoveries.

More recoverable crude oil (77.3 billion barrels) has been discovered since 1935 than was produced from 1857 through 1934 (62.0 billion barrels). At the end of 1974, however, the ratio of proved reserves to 1974 production was only about 11. Perhaps more significantly, the ratio of proved domestic reserves to 1974 consumption (of both domestic and foreign petroleum) was only 7.7.

In regard to these major earth resources, then, the United States in 1975 was substantially worse off than it was in 1935 only in crude oil. Despite large increases in consumption rates over the past 40 years, we now have many more "years" of lead reserves than we did 40 years ago, as well as about 25 percent more years of copper and zinc reserves--even if we were abruptly deprived of all imports of these metals. With continued imports, our iron-ore reserve position is much better than it was 40 years ago; without imports, we have lost only 4 years of reserves in 40 years. In the short term, and except for oil, Leith appears to have been wrong. [Note: Although this example covers only United States resources, it is similar to the kind of result found in world resource calculations.] The continuous-creation school of resource analysts would classify him as a doomsayer of the past whose forecasts went awry for the same reason that those of the present-day Cassandras will miss the mark, a lack of understanding of the impact on reserves of continuously improving technology, which geologist Nolan once called "the inexhaustible resource."

The view that advances in technology, stimulated by the market economy, will prolong the availability of a mineral commodity almost indefinitely or will provide adequate substitutes when rising cost begins to slow demand, has much evidence in its favor and many strong adherents. There is currently [1975] an oversupply of both copper and crude oil in the world, and the supply of ores of iron and aluminum, despite enormous increases in the production and consumption of both during the past 50 years, seems almost boundless.

Why, then, do some persist in the opposite view, that physical limits will slow or halt the development and utilization of most earth resources long before crustal concentrations can be regarded as reserves? Perhaps it is because they are impressed by the steepness of the geochemical gradients at the margins of most ore and fossil-fuel deposits, by the fact that such deposits do not show a compensating increase in tonnage of reserves (calculated as recoverable metal or fuel) as grade decreases, by the environmental limitations on their origin, and by the fact that the energy or work cost of recovery increases exponentially with decreasing grade of the ore or with increasing cumulative recovery in the case of crude oil.

## Examples of Exploitation Limits

The so-called porphyry copper deposits, which now produce more than half the world's copper, are worth looking at in the context of exploitation limits. They are sharply restricted in age of formation to three geological periods within the range of 30 million to 200 million years ago. They are associated with small intrusive bodies of stocklike form, averaging 1200 by 2000 meters in outcrop. The ore bodies tend to be pipelike and oval in plan, with dimensions of approximately 1000 by 2000 meters. Mineralization is in concentric zones, with the copper content in the center of the body reaching ten times that at the outer edge of metallization. Vertical dimensions can reach 3000 meters, but the pipe narrows downward. If, as Sillitoe believes, the porphyry copper deposit spans the boundary between the plutonic and volcanic environments, it occupies a very special geologic position indeed, sharply limited in both time and space.

The Toquepala and Cuajone mines in Peru are typical of the porphyry coppers. The mass of mineralized rock in these deposits has the shape of an inverted and truncated cone, within which the copper content ranges from 1.32 percent to less than 0.45 percent, the present cutoff grade below which mining and processing would be unprofitable. Rock containing between 0.20 and 0.45 percent copper is, however, being mined and stockpiled for later leaching by sulfuric acid. Below an average of about 1 percent copper, the copper content of the ore (Table 3) decreases sharply as the grade drops. The deposits, with the ore minerals irregularly disseminated through them, have rather sharp geochemical boundaries, and the diameter of the mineralized cone decreases downward. The energy cost per ton of refined copper of mining and milling the ore increases inversely with grade, and directly with depth.

TABLE 3

Relations of ore grade, copper content, and mining and milling energy at Cuajone mine, Peru. Values in the last column are $\Delta$ per short ton of copper, where $\Delta$ is the energy required to mine and mill a short ton of 1.00 percent copper ore. (To convert short tons to metric tons, divide by 1.1023.)

| Average grade (%) | Tonnage (thousands of short tons) | Copper content (thousands of short tons) | Energy needed to mine and mill ($\Delta$/ton) |
|---|---|---|---|
| 1.32 | 20,000 | 264 | 0.76 |
| 0.99 | 430,000 | 4,257 | 1.01 |
| 0.32 | 102,000 | 326.4 | 3.13 |
| < 0.20* | 1,057,000 | 66.6* | > 16,000 |

* Mostly barren overburden of post-ore volcanic rocks; calculated at crustal abundance for copper content and energy needed.

At Cuajone, if the ore cutoff grade were to fall from the present 0.45 percent to 0.20 percent, the total copper recovery would be increased by only 7 percent. At Toquepala, a similar lowering of the cutoff grade would increase recoverable copper by less than 4 percent. Because economies of scale appear to have been exploited fully, and because energy costs are rising, it does not appear likely that the ore reserves in these mines will be extended much either by technological advances or rises in the price of copper.

A tonnage-grade analysis of known North American porphyry copper deposits indicates that 70 percent of the copper metal is in deposits above 0.7 percent copper; lower-grade deposits do not represent increasingly larger amounts of copper, but the reverse. Analyses of the known deposits of the two other principal types of copper deposits, strata-bound and massive sulfide, suggest similar tonnage-grade relations. Significant, too, is the fact that the rate of additions to reserves of copper metal appears to have been falling off since 1960, during a period when the price of copper has risen strongly; here it is important to distinguish between tonnage of ore and tonnage of contained metal. Many more deposits will need to be found, and at a faster pace than recently, if copper production is to continue at high levels into the coming century. Furthermore, there appears to be a geochemical barrier to copper recovery at about 0.1 percent copper, below which most copper is in solid solution in common silicate minerals and is not amenable to selective physical or chemical extraction.

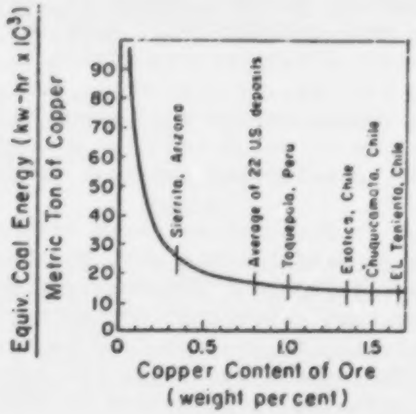
The basic question in forecasting earth resource exhaustion is whether or not the energy-profit limit will be reached, or demand will cease, short of attempts to extract the desired resource from ordinary rock and seawater. For some resources, we can say with assurance that the energy-profit limit will be reached long before ordinary rock can be mined profitably. The fossil fuels are the best and most important examples. The energy potential represented by the average concentration of carbon in the earth's crust is 2.9 kilowatt-hours per metric ton, not nearly enough to crush and grind it to liberate the carbon for use. We can thus be sure that the sharp physical boundaries that characterize coal and petroleum deposits are also economic boundaries. In fact, for most petroleum deposits the economic limit of exploitation lies within the deposit rather than at its margins; oil clings so tenaciously to the pore walls of reservoir rocks that to flush it all out would require more energy than can be gotten from it. The curve of incremental recovery against energy cost is steeply exponential for so-called tertiary recovery techniques, and to achieve an average cumulative recovery ratio of even 40 percent from American reservoirs will require much higher prices for oil than can now be foreseen.

On the other hand, there are very large low-grade deposits of uranium in which the potential energy is more than sufficient to break, transport and pulverize the rock, and then to recover the uranium.

Breeder reactors converting 60 percent of the potential energy of uranium to thermal energy and 40 percent of that to electricity could produce more than 5500 kilowatt-hours per metric ton of average crustal rock, which might allow an energy profit to be returned. The question here is the amount of energy required for mining and milling very low grade ore. Not only does the tonnage of ore necessary to produce 1 ton of metal increase hyperbolically as the grade decreases (Fig. 1), but the energy input per ton of ore ground increases as the size required to liberate small particles of ore decreases.

FIGURE 1

Equivalent Coal Energy Requirements for Different Grades of Copper Sulfide Ores. Grades of some copper deposits are shown. Source: N. J. Page and S. C. Creasey, J. Res. U.S. Geological Survey, 1975.



As ore grade decreases, the percentage of the valuable metal recovered in milling decreases; this falling off in recovery efficiency has the effect of increasing the energy cost per unit of refined metal. Finally, the ore generally gets harder to break and more expensive to lift as mining goes deeper; therefore, the energy costs of mining (per ton of recovered metal) tend to increase as exploitation continues.

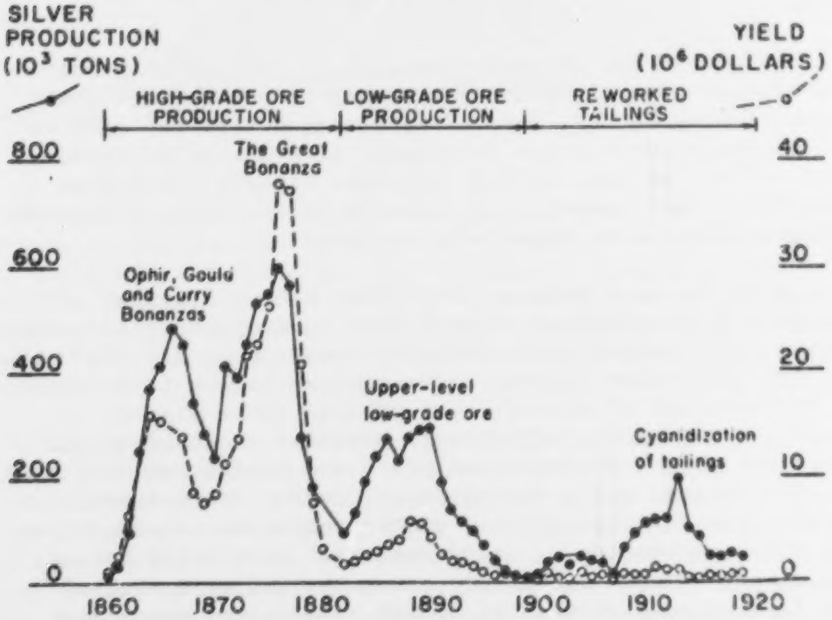
In general, the energy required to produce refined metal from low-grade ores becomes extremely high at grades that, except for iron and aluminum, are well above the corresponding crustal abundances. Except in the cases of strip-mined coal and Persian Gulf oil, the energy costs of obtaining useful energy are rising as found sources grow deeper, leaner, and more recalcitrant or refractory. Coal exploitable by stripping and Persian Gulf oil are clearly finite, and production of both is likely to wane within 25 to 50 years. Increased costs of obtaining useful energy, and higher work costs of exploiting leaner or more refractory materials, will tend to raise present ore cutoff limits and thereby to reduce reserves, while technologists continue the struggle to lower cutoff grades and augment reserves. Only a breakthrough of new technology that results in a substantial lowering of energy costs would reverse what appears to be a tightening of the drawstring on nature's bag of nonenergy resources. The breeder reactor may represent such a breakthrough; fusion might some day be another.

## Depletion Histories

The history of a mining district or of an oil field has a beginning and an end, separated by a productive period. Some histories end abruptly, others are drawn out. Resurrection is rare. The history of the Comstock silver lode (Fig. 2) illustrates a simple depletion pattern characteristic of high-grade, sharply bounded, vertically limited mineral deposits.

FIGURE 2

Production history of the Comstock Lode in Nevada. The data for 1860-1881 are from E. Lord; the data for 1882-1920 are from G. H. Smith.



The system is rich an intricate near the surface, barren and simple a few thousand feet below. Its production history shows three distinct stages: in the first stage, during which the greatest part of the lode's total value was extracted, high-grade ore was mined at a fast rate. In the second stage, it became possible because of technological improvements to mine lower-grade material bypassed in the first stage. In the final stage, waste material and some very low grade ore were processed by a new technology, but little was added to the value already produced.

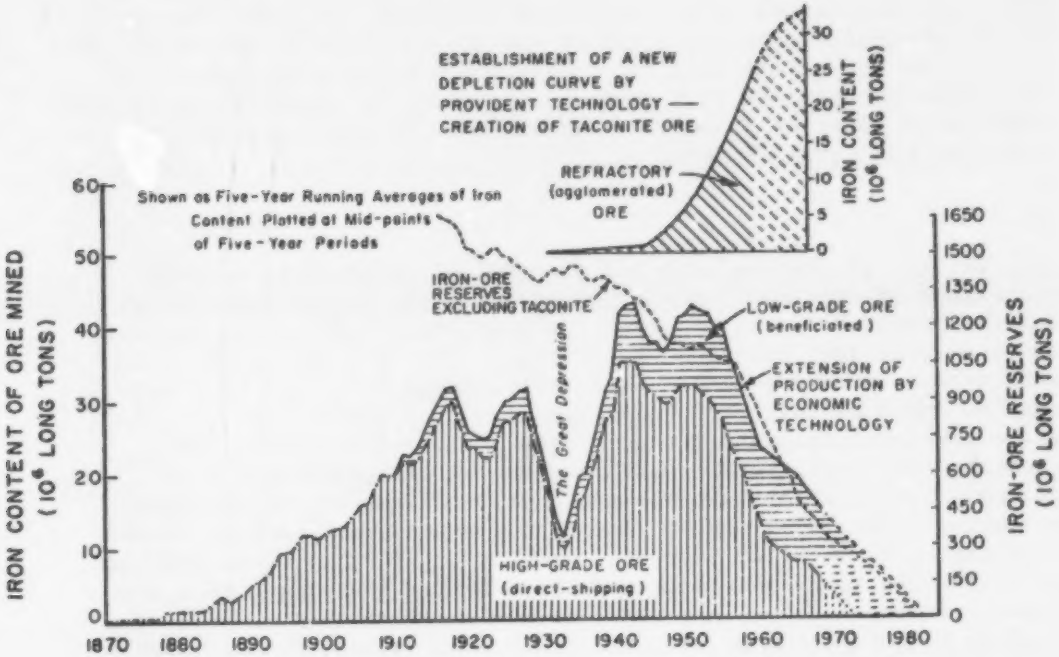
Somewhat different from the history of the Comstock is that of the Lake Superior iron district. Depletion of the rich "direct shipping" ores of that district is almost complete (Fig. 3). These ores, created by a geologic process related to groundwater levels and to the particular geologic configurations of the district, had sharp physical boundaries that coincided with economic limits. In the waning stage of production, upgrading of low-grade material into shippable concentrates added substantially to total production, but delayed exhaustion by only a few years. However, the Lake Superior district has been revived through a technological breakthrough that created a very large resource out of a previously worthless iron-bearing rock called taconite. Such provident technology can be effective only where there is a deposit, already concentrated by natural processes, characterized by a refractory host or reservoir rock. Taconite production, now in its youthful stage, will also pass through maturity to exhaustion.

Iron and aluminum are abundant elements in the earth's crust. For each, there are several kinds of geologic concentrations that represent actual or potential resources; consequently, for each we may expect the depletion history to consist of a series of production history curves, as availability and cost dictate a steplike descent from high-grade hematite to taconite to iron-rich intrusive bodies; and from bauxite to high-alumina clays.

When we move in scale from an individual mining district to a country, we find fewer examples of completed production cycles. Mercury, however, is an essentially exhausted resource within the United States, and its production history shows some significant relations to price. Exploitation of mercury went through three phases: a growing phase, during which increases in production caused the price to fall; a mature phase, during which price and production were more or less in equilibrium; and a waning phase, during which successive surges in price evoked progressively weaker responses in production. The growing phase represents a period when real cost falls because of new discoveries, technological improvements, and economies of scale. The falling cost stimulates demand. Increased production hastens the exhaustion of high-grade, low-cost deposits and puts pressure on technology to counter increasingly adverse geologic and geo-

FIGURE 3

Depletion history of Lake Superior district iron ore, showing overlapping stages of depletion of a mining region.



graphic conditions. When technology begins to lose the battle, real cost rises and the waning phase is entered. Prices rise with increasing costs of production and demand falls. Sharply rising prices stimulate the search for a substitute, either imports of the same substance or domestic production of a replacement material. If a substitute is found, domestic production of the resource ceases; if not, it is stretched out, diminishing slowly as demand wanes.

The relation of production and price curves for U.S. silver is similar to that for mercury, and the curves for crude oil are developing in like fashion. During the growing phase of U.S. oil production, gluts of oil drove the price down to or below the actual cost of production. Proliferation of automobiles and trucks was stimulated by cheap fuel, and demand grew. The passage to the waning phase, about 1971, was abrupt because of the large cost differential between domestic and foreign crude oil at a time of strongly rising demand, a differential that forced a rapid shift from domestic production to imports. Current, artificially high, world crude-oil prices have encouraged exploration for new domestic reserves and have stimulated new efforts to recover more oil from existing wells. It is almost certain, however, that we shall not see a production response equivalent to the price rise because the costs of finding and recovering crude oil (and natural gas) increase exponentially with depletion. If the present cartel of oil exporting countries collapses and world oil prices fall sharply, the end of the U.S. production curve will be abrupt. If the cartel does not collapse but an adequate supply of substitute energy, say from coal or oil shale, is developed at or near the present price of crude oil, the end of U.S. crude production will be slower but similarly assured.

## Conclusion

In view of the geologic and geochemical constraints on the occurrence of economic deposits of minerals and energy resources, and the advanced nature of present exploitation techniques, we must conclude that such resources are finite. The "endlessly retreating" interface between ore and almost-ore that some optimists have described could be validated only if the cost of useful energy would endlessly and acceleratingly decrease. On the other hand, the question "When will we run out?" bespeaks a misunderstanding of geologic resource limits. The world will not run out of geologic resources. They will merely become more expensive. As they become more expensive their utility will diminish, either by human decision or by failure to achieve an energetic profit. How expensive a geologic resource becomes, and how fast its real cost rises, will depend on a combination of geologic and technological factors. Depletion (rise in cost) is swift for those materials found mainly in sharply bounded, highly concentrated deposits--especially swift if they cannot be recycled after use. Depletion is slow for abundant materials found mainly in deposits of relatively low geochemical concentration with gradational boundaries--especially slow if they can be recycled after use.

[Extracted from Science, Vol. 191,
No. 4227, February 20, 1976, pp.
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☆ U.S. GOVERNMENT PRINTING OFFICE: 1980—310-828/2

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VOL. XVIII • NO. 3 • JULY 1980

# DEVELOPMENT DIGEST

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The DEVELOPMENT DIGEST is prepared for the Agency for International Development by the National Planning Association, a private, non-profit organization in Washington, D.C.

We would appreciate comments of an editorial nature and suggestions of material for possible inclusion in the DIGEST. Please address:

Editor: DEVELOPMENT DIGEST
National Planning Association
1606 New Hampshire Avenue, N.W.
Washington, D.C. 20009

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Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 2, 1966.

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A quarterly journal of excerpts, summaries, and reprints
of current materials on economic and social development

Gordon Donald, Editor; Anthony Pearce-Batten, Associate Editor;
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Prepared by the National Planning Association

for

Agency for International Development, U.S. Department of State

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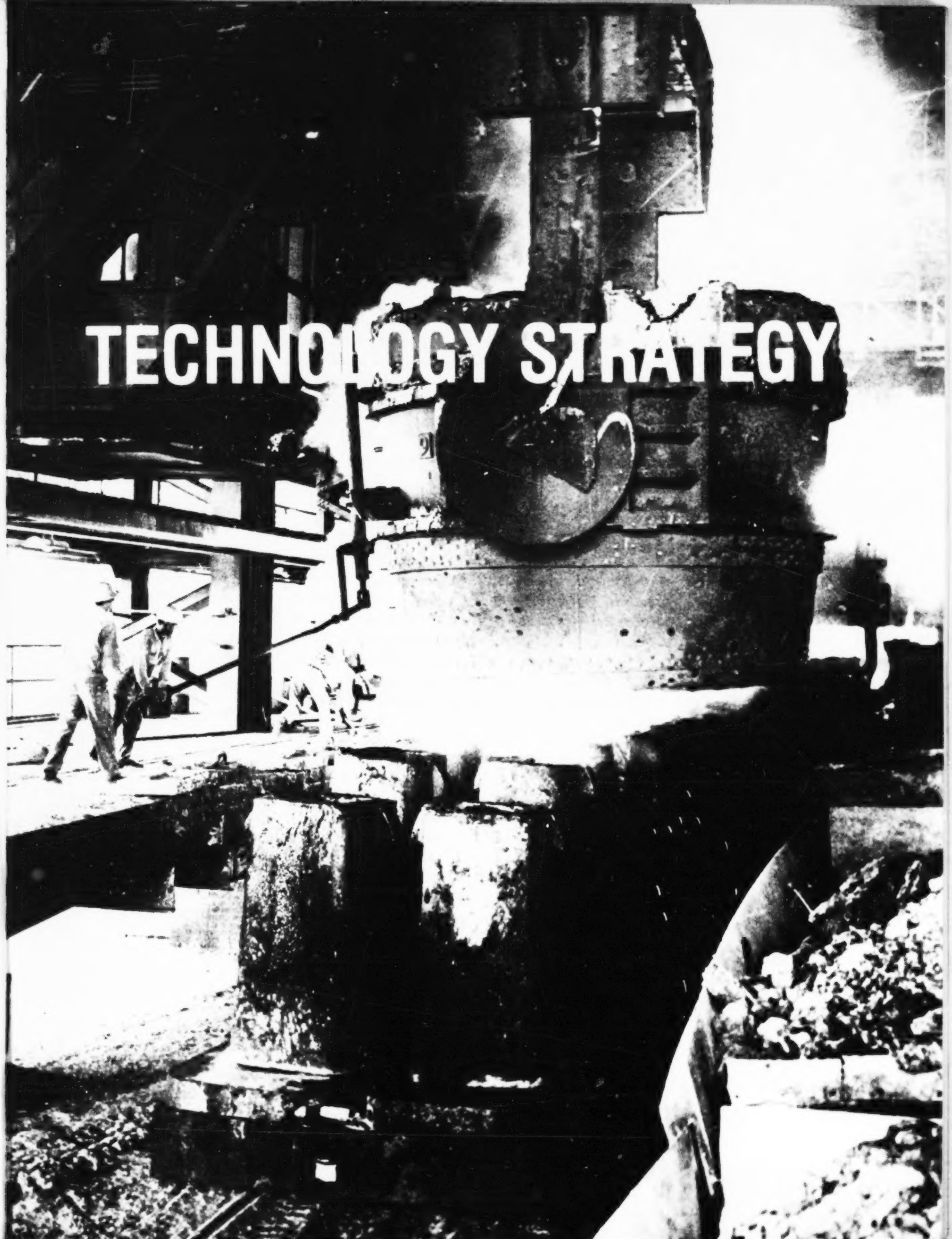
# TECHNOLOGY STRATEGY



Workmen at the Volta
Redonda steel mill in Brazil
prepare to pour molten metal
into molds. (Photo: USIS)

# Development of Technology: The South Korean Experience

Hyung-Sup Choi

[South Korea's great success in industrialization in the 1960s and 1970s resulted in part from labor-intensive export industries and low-cost (but skillful) labor. At the same time operation of increasingly sophisticated methods in "leading industries" and an intensive educational drive have markedly raised the nation's capabilities and self-reliance. Less publicized but highly important in the growth process has been the upgrading of technology in rural areas.]

Perhaps more significant than the present array of fantastic new technologies that have sent man to the moon is the emergence of new perceptions about the role of technology in society. For a long time technology was viewed as a common good having only positive value; it was sought after and often unconditionally accepted and praised. But more recent experiences in the development and deployment of technologies give evidence that technology does not always fulfill its purported objectives. We have learned that technology is no more and no less than one important means to many different ends.

Some of the "leading industrial sectors" in a developing country are geared primarily toward breaking the inertia of underdevelopment. They introduce technologies which are quite advanced relative to the country's absorptive capacity. But the "feeder" industries that support these leading sectors do not necessarily require such advanced technology. It is therefore desirable to look at development from both the national and the local points of view, so that production plans involving both leading and feeder industries can be realized.

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## Industrial Development in South Korea

The following statistics give some idea of what conditions were like in Korea around 1959-61, the period preceding the launching of the country's industrialization effort under the First Five-Year Economic Development Plan. First, Korea's GNP growth rate averaged 3.3 percent per year, and population growth was 2.9 percent. The per capita income was under $100; 65 percent of the work force was in primary industries, while secondary industries (mining and manufacturing) employed only 6.9 percent. In terms of per capita output, using an index of 1.0 for the national average, primary industries registered 0.65 and secondary industries 2.60. The domestic savings ratio to GNP was only 3 percent. The Korean economy was from the beginning an open one; this was necessary to obtain foreign investments. On the whole, then, Korea offered a perfect example of an underdeveloped, stagnant economy.

Initially, Korea opted to develop light, labor-intensive industries by absorbing the labor force from the primary sector. The effective demand for industrial products in the primary sector was all too slight, and it was necessary to look elsewhere in search of capital, markets, and technology. Instead of initiating a pattern of import substitution to be followed by export development, the two were undertaken almost simultaneously, particularly when the first five-year plan went into effect. The apparent success of this bold approach can be attributed to several factors: (1) the capacity of the labor force to deal with technologies which were relatively sophisticated; (2) close trade relations with the United States and Japan, both of which are big markets; (3) full exploitation of the technical advantage of being latecomers in industrialization; and (4) the capacity to adapt to the international economic environment -- a capacity that was actively supported by the government through the creation of a favorable climate for foreign investment.

The most conspicuous constraints on the scheme for rapid industrialization were deficiencies in the social service sectors. The infrastructure for industrial development was very poor, and the government placed greatest emphasis on the building of roads and ports, communications, and other essentials to development, including expanded educational facilities, particularly for technical training. About 50 percent of the total foreign capital in Korea, as well as over 70 percent of the total public loan funds from overseas, were spent on infrastructure.

During the first five-year plan (1962-1966), there was considerable debate in the course of choosing an appropriate technology. The essential criterion was that the choice of technology had to fit the scale of a project. For instance, the construction of an innovative, integrated iron and steel plant with an annual production capacity of less than 400,000 tons was contemplated. This, however, was less than the optimum size required for the introduction of modern production methods. Since it was virtually impossible to set up an efficient, integrated operation, the establishment of such a plant was deferred until the second five-year plan, when a plant could be established with a capacity sufficient to justify, for instance, a tandem rolling mill. The introduction of the L.D. converter was in itself a breakthrough for those who had experience only with open hearth or electric furnaces. But it was necessary to wait another several years before a highly sophisticated continuous casting mill could be added to the steel-making plant, and before sufficient experience had been acquired in the operation and maintenance of conventional methods.

The second Five-Year Economic Development Plan (1967-1971) placed emphasis on initiating the "lead sectors" approach and pushed forward with the development of basic chemical industries (such as fertilizers, cement, and petro-chemicals) as well as the iron and steel industry. What was attempted through these sectors was the initiation of a growth momentum that would make itself felt within all Korean industry. These industries are highly capital-intensive and need a huge infrastructure which has to be supported by the government, but they are essential to the foundation upon which the high-linkage industries can be built. In formulating the second five-year plan, a series of bold quantitative tools for constructing development models was introduced. These models were most important in articulating Korea's socio-economic goals, identifying potential industrial growth patterns and major constraints in reaching those goals, and for formulating investment programs.

The idea behind the "lead sectors" approach, along with the use of foreign experts, was to allow greater latitude for debate on the plan so that a defensible strategy would necessarily follow. It is noteworthy that the experts often turned out to be too conservative at both the micro- and macro-planning levels. The dynamism of a developing-country economy -- if it ever does achieve real momentum -- is difficult for the experts to predict. Excessive conservatism can be very troublesome if it occurs in the planning for a key sector, because the forward motion of the whole effort may be brought to a complete halt. Becoming overly optimistic can also be troublesome, however, since it may result in tying up non-productive capital in excess capacity. Thus, one pressing question in developing lead-sector industries was whether or not they could operate at full or at least near capacity. It was found that the range of choice was extremely small because the cost of capital for these industries, which for the most part originated abroad, was very much higher than for the advanced countries. Recognition of this hard fact of life had much to do with the makeup of any industrial project.

The Third Five-Year Economic Development Plan (1972-1976) followed more or less the same direction as the earlier ones but with greater economies of scale in agriculture and social services, capitalizing on the previous experiences of the advanced countries and the improved capacity of the home country itself. This orientation necessitated the introduction of unprecedented numbers of newer and higher-level technologies into Korean industry. The decision was irreversible insofar as scientific and technological development were concerned: it was an issue of survival or extinction in ever-increasing international competition. Korea's experience in the past decade, particularly with reference to the relationship between commodity exports and royalty payments for foreign technologies, indicates that a close positive correlation exists between the two: an adequate supply of appropriate technologies is the essential factor in enabling industry to produce the goods and services demanded in international markets.

Korea's science and technology development policy today hinges on the proper selection, assimilation, and adaptation of imported technologies. Throughout the first development periods, foreign technologies were often accepted along with the inflow of capital, largely because of the strongly felt need for foreign capital. (Statistics on technological agreements *per se* tend to underestimate the amount of imported technology.) The range of technological choices was often limited, and technology itself was treated as though it were only of secondary importance. But that situation has changed. The specific need for particular technologies, as distinguished from capital, has been recognized. The achievement of a comparative advantage which relies heavily on low labor costs and the use of manual workers is untenable in the long haul. For many developing countries, the day for achieving a better balance in the employment of manual and highly skilled workers should not be in the distant future.

The three successive five-year economic development plans culminated in success beyond our expectations. GNP growth averaged 10 percent per annum in real terms. The manufacturing sector alone attained, on the average, a 20 percent growth rate per annum. Exports, 90 percent of which consisted of manufactured goods, amounted to (U.S.) $8 billion in 1976 compared to $55 million in 1962, increasing approximately 150-fold in 15 years. By the time the Fourth Five-Year Plan ends in 1981, it is envisaged (with some optimism) that the Korean GNP will reach $58.7 billion -- $1,512 per capita. The export target for 1981 is set at $14.2 billion in 1975 constant prices, representing an annual growth rate of 16 percent after correcting for inflation.

## Developing an Infrastructure for Technology

Depending on a host of problems, such as the lack of institutional frameworks within which people can function, the lack of legal bases for providing incentives to develop technology, and most of all the lack of qualified people, various approaches can be devised (perhaps differing from country to country) for developing appropriate infrastructures conducive to the development of technology.

It has been said that the development of technology within a developing country is, for all practical purposes, out of the question. It is often asserted that any need for sophisticated technologies can easily be met through the transfer of technology from developed countries, as though it could simply be picked off a shelf. This kind of thinking is not without some justification, but it grossly oversimplifies to the point of collectively condemning what in fact may be worthwhile, necessary, and even noble initiatives on the part of the developing countries. A pressing need to possess indigenous sources of technological development in tune with national requirements is widely felt in the developing countries. One of many formidable questions that need to be addressed is: What kind of technology should a society seek to develop?

The literature on appropriate technology is replete with elaborate treatises on the attributes of technology, but there is less on the attributes of development tasks themselves, which cannot simply be translated into terms of employment or income distribution no matter how pivotal their importance. It is not difficult to achieve a consensus among people of different backgrounds that the appropriateness of the technology depends to a great degree on needs and capabilities. We can further conclude that needs must be identified *before* formulation of any plan for technological development. The pivotal problems are how to ascertain needs, and how to assess latent capabilities, so that they can be translated into development programs. These tasks are most difficult for developing countries, since such capabilities are often inadequate or even lacking. It is especially in this area that international cooperation should play a complementary role if any real progress is to be made.

The appropriateness of technology is often measured in terms of the labor/capital requirement ratio, the level of requisite labor, and the necessary material input. These considerations stem from the assumption that technology is to be chosen only *after* goals have been delineated. There is nothing wrong in doing so, but it fails to take note of another vitally important role that technology should play in the process through which goals are defined. The mere assessment of the appropriateness of the technology, using conventional yardsticks, often fails to take into consideration various other important factors, such as a developing country's absorptive capacity, which depends on many institutional, legal, cultural, environmental, and even ecological factors. Perhaps the biggest problem facing developing countries with respect to appropriate technology is that of establishing harmony between rapidly rising aspirations and the slowness of progress. The cost to the developing countries -- both in political and economic terms -- of exercising a degree of patience rather than allowing rapid growth to skew development into the lead sector will vary from one context to the next. In all contexts, however, the attempt to balance immediate needs against long-term goals requires political will and sound leadership that goes beyond technical considerations.

Korea's creation of an institutional framework was comprehensive, including, among other institutions: (1) the Ministry of Science and Technology (MOST) established in 1967 as the central planning, coordinating and promotional body in the government; (2) the Korea Institute of Science and Technology (KIST), established in 1966 as an autonomous, multidisciplinary, industrial research institute chartered as a contract research organization; (3) the Korea Advanced Institute of Science (KAIS), founded in 1971 as an autonomous institution supported chiefly by the Ministry of Science and Technology, with the mission of training high-caliber professionals in selected applied sciences and engineering; and (4) a great number of vocational training institutes and technical high schools to meet the rapidly rising demand for skilled workers and technicians.

The new Ministry of Science and Technology spearheaded the enactment of several laws of importance for the development of science and technology, including: (1) The Science and Technology Advancement Law of 1967, which defines the basic commitment of the government to support science and technology and to provide policy leadership; (2) The 1972 Law for the Promotion of Technology Development, which, among other things, provides financial incentives to private industries for technology development; (3) The Engineering Services Promotion Law of 1973, which promotes local engineering firms by assuring markets on the one hand and performance standards on the other; (4) The National Technical Qualification Law of 1973, which, through a system of examinations and certifications, promotes the abilities and professional status of those in technical fields; (5) The Assistance Law for Designated Research Organizations of 1973, which provides legal, financial, and fiscal incentives for research institutes in specialized fields on which the government and private industry place particular emphasis (e.g., shipbuilding, electronics, communications, mechanical and materials engineering, and energy and related areas); and (6) The Law for the Korea Science Engineering Foundation of 1976, which provides a legal basis for the

Foundation to act as the prime agent for strengthening research (mainly university-based research) in basic and applied sciences as well as engineering, and to facilitate more rapid application of science and engineering to national needs.

The Korea Institute of Science and Technology (KIST) was brought into being to bolster the industrial sector, particularly in areas emphasized by the national economic development plan, by eliminating bottlenecks that hinder further growth. The Institute was made a contract research organization -- to make researchers problem-oriented and to help make underwriters of R&D aware of the importance of its results.

Before it undertook research of any kind, KIST carried out a comprehensive study to ascertain the actual needs of Korean industry. A study was made of 600 industrial plants and related organizations covering 25 industrial sectors. This study took eight months to complete and involved 80 specialists, 23 of whom were brought from overseas. The survey helped to identify the main areas of concentration for the Institute during its initial period of operation. Studies similar to this initial comprehensive survey are carried out periodically to ascertain industry's ever-changing requirements and to maintain the Institute's capability to solve them. Among the operations set up within the Institute were: (1) a project development department to promote the concept of scientific research among industrial firms and to help industry formulate questions to ask the Institute, (2) a cost accounting system to compare input with performance, and (3) the establishment of a large endowment fund to enable the Institute to undertake long-term research for which no particular client could easily be found. To avoid the rigidity inherent in departmentalization, a multidisciplinary approach was emphasized throughout the Institute.

As industry grew, its technological requirements increased in level and diversity. Some of the Institute's laboratories, such as those in shipbuilding and petrochemicals, were no longer able to render the necessary technical support to their industries. An independent research organization specific to each industry and problem area thus became necessary. Creating completely new organizations would have been a formidable task, so some of KIST's existing laboratories were spun off the mother institute. Thus, they inherited not only the knowledge that had already been accumulated, but also a workable and working management system and philosophy, which all too often are missing or amorphous in a new organization.

The vast importance of industrial research has only recently been recognized. It not only provides support for economic development, but, even more importantly, helps create the framework within which economic development strategies are formulated. Industrial research is essential to the realization of a nation's industrialization goals, and, if properly carried out, can help in setting reasonable and feasible goals. Korea has made substantial gains, through much trial and error, in improving its scientific and technical capabilities, improving administration and support systems, and increasing as well as orienting R&D investment. The total effort was intended to change the economy from a simple labor-intensive to a technology-intensive, and ultimately skill-intensive, structure. In other words, the effort was designed to accelerate the transformation of Korea's science and technology infrastructure from a supporting role in national economic development to a leadership role in creating a technologically self-reliant economy in Korea by 1980.

## Transfer of Technology Within Countries: A Relatively Unexplored Frontier

While international technology transfer has been much in the limelight, surprisingly little attention has been given to the crucially important transfers between urban and rural areas, between industry and agriculture, and between business firms of varying sizes. Without a means for active transfer of technology *within* countries, development efforts are futile. The idea is not new, but it probably has not been pursued widely or conscientiously enough. At the macro-level -- for instance, in trying to bridge the gap between the urban and rural economies -- probably every developing country has tried some type of deliberately planned program of internal technology transfer; Korea's experience parallels some of these efforts in objective and perhaps in approach as well.

Korea's massive program, called Saemaul Undong, which means new community movement, was undertaken at the national level and involved myriad programs, ranging from digging or improving sewage ditches to applying new farming techniques. The program also aimed at bringing about selective rural industrialization -- through the offer of incentives -- in the belief that the rural labor force could make a contribution to the development of industry. It became apparent, however, that it would take more than an abundant labor force to make industrialization of rural areas feasible. Many inherent difficulties quickly became obvious, making it necessary to readjust the time schedule for locating industry in rural areas. Upgrading living conditions and introducing means of earning supplementary income was made a major objective. The government channeled support to about 20,000 villages, with the support varying according to the extent of self-help displayed and the nature of the jobs to be done. For the last two consecutive years, rural household income in Korea has slightly surpassed that of urban households, perhaps for the first time in modern history. Many attribute that result to this program.

Dr. Vincent Brandt, an American anthropologist who has been studying rural Korea for some years, finds that rural development gained substantial momentum since the early 1970s for the following reasons. First, there were profound and irreversible modernizing changes in rural attitudes and in the operation of village institutions, particularly after the successful land reforms of the early 1950s. Second, government efforts placed less emphasis on farmers' psychological motivations and more on furnishing essential assistance to agriculture in terms of credit and technical advice, and by providing better organizational linkages between the villages and the national economy. Third, improved communications and transportation have played a part in this progress, as have movements of population (e.g., the thousands of people who returned to their villages after military service and others who have moved to urban areas have all established contact points between urban and rural areas). A fourth factor was the transformation of local bureaucracies, which used to be more resistant to innovation than the farmers. This change was due mainly to an unswerving government commitment originating with the chief of state.

Once these changes were under way in Korea, many scientists and professors working in science and engineering realized that they might have something useful to contribute to rural development as volunteers -- even in the little time available to them for such an activity. The Federation of Scientific Societies set up a small secretariat to coordinate such activities, initially with the token participation of about one hundred people. In only two years this has grown into a technical service corps with a network of eight provincial secretariats.

Much to the surprise of the participants, these professionals found many problems for whose solution their expertise was inadequate. At the same time there were many other problems with which they could offer immediate help. Designing a concrete bridge across a creek, for example, was one day's homework for a college-level civil engineering student. An even more important result of these interfaces of scientists and engineers with people at the grassroots level was the two-way learning process that occurred. The rural people learned much from having presented their problems to academicians who, in turn, obtained invaluable insights on how education should prepare people to solve practical problems. It was heartwarming to see how people with such different social and educational backgrounds were able to communicate with each other to solve problems.

In the final analysis, then, the establishment of an infrastructure conducive to innovation should receive the highest priority at the national level. The government's role is pivotal in the accomplishment of this task. One lesson learned from this experience is that the pool of knowledge and the existing state of the arts can be applied to solve a broad range of rural problems -- provided that the agents (not necessarily agencies) are motivated to work with people at the grassroots, even when they have only limited time to devote to such work. Although there is no remuneration for services, the involvement of academics and laymen alike has increased as the program has progressed. Perhaps the most important result of the program is increased awareness of the need for technology transfer within countries -- and of the immense economic as well as moral benefits that accrue from it.

## Conclusions

Korea's particular experiences suggest several conclusions that can be made about the developmental process in general. First, for countries that suffer from the vicious cycle of economic underdevelopment, it is imperative, initially, to pursue development in some leading sectors with a daring mix of technologies and entrepreneurship. Second, a massive campaign to mobilize in-country talent and bring it to bear on problems at the grassroots level, be they agricultural or industrial, must be undertaken. Third, the developing countries cannot allow themselves to be swayed by the prevalent notion that the generation of technology in developing countries is uneconomical, if not impossible. On the contrary, there appear to be vast possibilities, even an absolute need, in the developing countries for the generation of technologies by those countries themselves.

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# Licensing and Self-Reliance In the Andean Group

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[The objective of technological self-reliance means that a nation aims to acquire the capacity to assimilate and later to improve on imported technologies. A study of firms in two modern industries in three Andean Group countries indicates some of the factors conducive to growth in self-reliance.]

## The Route to Self-Reliance in Technology

This paper explores the extent to which licensing promotes technology transfer and future technological self-reliance in 47 metal-working and 43 chemical firms located in Peru, Ecuador and Colombia. By definition a technology transfer implies the assimilation of imported technology by a recipient firm. In time, the firm may also develop the in-house capabilities to adapt, extend and perhaps improve upon the imported technology. All these capabilities are necessary components of a strategy of technological self-reliance.

A strategy of technological self-reliance seeks to accomplish two basic objectives. The first is to maximize the developing country's choices through increased knowledge and capability. This means developing the evaluative skills which permit appropriate choices of technique, as well as bargaining skills which make it possible to obtain improved terms for technology imports; and the research and development (R & D) skills which enable the firm to "depackage" technology, purchase components from least-cost suppliers, develop elements of the package themselves or extend the technology in order to

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diversify product lines. Historically, R & D in large, multinational firms has been biased towards innovation related to the conditions which prevailed in their principal markets in the industrialized countries of the world. Therefore, a strategy of technological self-reliance for developing countries must seek to foster local research and development into products and processes appropriate to domestic needs, resources, incomes and tastes -- the second major objective.

Most Third World countries have neither the technological base nor the structure of demand for technology to make the assimilation of imported technology and its adaptation, extension and improvement a quick or easy process. Thus, it is argued, in order to maximize the likelihood of a real technology transfer, recipient firms within this environment will have to consciously engage in activities which permit "learning by doing" -- that is, to seize every opportunity to solve problems associated with the choices of technique, of machinery and machinery suppliers, and of the very products to produce. In this way they will develop the in-house capability to assimilate imported technology. To move beyond assimilation towards future technological self-reliance, recipient firms would then have to embark on a process of "technological apprenticeship", that is, a process stressing the adaptation and marginal improvement of products and/or known techniques of production (rather than the development of new products and/or productive techniques). This presupposes the creation of in-house research and development capabilities. Whether this process of technological apprenticeship will lead to major indigenous innovations is not at issue here; a strategy for technological self-reliance is not intended to be a blueprint for autarky.

## The Sample of Andean Pact Firms

Initially the project from which the data presented here were derived was designed to explore the impact of Andean efforts to regulate technology transfer and direct foreign investment through Andean Group Decision 24 in 1971 (see Development Digest, January 1974, p. 81). The 90 firms selected for inclusion in this study, therefore, do not constitute a random sample of firms in the Andean region; instead they represent nearly all the cases in 10 product sectors within the chemical and metalworking industries -- two industries of considerable significance for Andean industrial programming activities -- in those three Andean countries where relative political stability ensured no major discontinuities in the implementation of Decision 24 during the first five years following its adoption. While the study represents an accurate picture of relationships in these product lines and for these particular countries, generalizing these findings to other industries or countries would be inappropriate.

Of the 90 firms, 20 were Ecuadorian, 37 Colombian and 33 Peruvian. By 1975, 44% of the chemical firms and 32% of the metalworking firms had been in production for more than 15 years. Nineteen percent of the firms in the survey were foreign-owned corporations, 9% were state corporations, a further 9% were mixed-private corporations, 39% were nationally-owned corporations and 24% were nationally-owned family firms. Table 1 explains this classification and provides data on the firms by ownership structure and product sector.

Table 1. *Product sector by ownership structure* of the firm*

| | Ownership structure | | | | | | |
|---|---|---|---|---|---|---|---|
| | | State sector | | | | | |
| Product sector | Foreign corps | Mixed | Nat'l | Mixed pvt. | Nat'l pvt. corp | Nat'l family | Total |
| Fibres | 2 | 2 | 0 | 0 | 0 | 0 | 4 |
| Plastics | 5 | 0 | 2 | 3 | 3 | 1 | 14 |
| Paints | 2 | 0 | 0 | 1 | 3 | 6 | 12 |
| Soaps | 0 | 1 | 0 | 0 | 3 | 2 | 6 |
| Chemicals | 3 | 0 | 1 | 0 | 2 | 1 | 7 |
| Total chemicals | 12 | 3 | 3 | 4 | 11 | 10 | 43 |
| % of chem. indus. | 28% | 7% | 7% | 9% | 26% | 23% | 100% |
| Electrical machinery | 3 | 0 | 0 | 1 | 2 | 1 | 7 |
| Industrial machinery | 0 | 0 | 0 | 0 | 10 | 2 | 12 |
| Foundry parts | 1 | 0 | 0 | 1 | 4 | 3 | 9 |
| Tools | 1 | 1 | 0 | 1 | 5 | 2 | 10 |
| Finished goods** | 0 | 0 | 1 | 1 | 3 | 4 | 9 |
| Total metal | 5 | 1 | 1 | 4 | 24 | 12 | 47 |
| % of metal indus. | 11% | 2% | 2% | 8.5% | 51% | 25.5% | 100% |
| TOTAL ALL SECTORS | 17 | 4 | 4 | 8 | 35 | 22 | 90 |
| % all sectors | 19% | 4.5% | 4.5% | 9% | 39% | 24% | 100% |

*This classification is based on Decision 24 of the Andean Group. Foreign corporations are either wholly-owned subsidiaries or firms in which less than 20% of the shares are held by nationals. State-controlled firms are those in which the state wholly owns the corporation or owns a minimum of 30% of the shares (generally along with a foreign multinational corporation) but exercises effective control over crucial planning decisions within the firm. Mixed private corporations are firms in which nationals own between 51 and 80% of the shares. In both national corporations and family firms nationals own 80% or more of the shares but in the case of the latter the firms are not public corporations.

**Includes airplanes, toys and other finished metalworking products. These firms were selected because they produce a product covered by the metalwork programme but often did not produce this product as their major product. The above classification is based on the major product of the firm defined in terms of the total value of production.

The 82 firms which supplied data on the total capital of their firm in 1974 were divided into thirds and categorized as small, medium and large. Ecuadorian firms in this survey tended to be small (29%) or medium sized (47%); 45% of the Ecuadorian firms were family firms, and 72% of the family firms in the survey as a whole were small. The reverse situation pertained in Colombia where 54%

of the firms were large, 20% medium and only 26% small. Some 32% of the Colombian firms in these ten product sectors, however, were foreign-owned and 63% of the foreign firms in the survey as a whole were large. Peruvian firms approximated the Ecuadorian pattern -- 43% small; 40% medium; 17% large -- but differed in that the stringent application of divestment regulations during the Velasco period had eliminated the wholly foreign-owned firm from these product lines by 1975, the year in which this survey was undertaken.

Licensing was the most common means of obtaining industrial technology in these metal-working and chemical firms. Of the 90 firms in the survey, 49 (54%) license the technology for one or more of their major products. The remainder acquire whatever technology they need, either autonomously through the experience of their personnel (29%), or through non-negotiated means such as: copying imported products (8%, all metalworking firms), direct purchase of machinery and processes (3%), or informational diffusion through journals and professional meetings (6%).

## The Analysis

As Table 1 illustrates, the structure of ownership in these Andean firms and the product sectors in which they are located were closely related. Foreign firms in particular clustered in industrial sectors noted for the complexity and volatility of their technologies, sectors in which their technological advantage permits the exaction of monopoly rents. Nationally-owned firms, on the other hand, were dominant in the metalworking industry and in the simpler, more stable technological sectors of the chemical industry.

Ownership structure, product sector and firm size, moreover, correlated highly with the decision to license technology. Using a stepwise discriminant function analysis, only these three variables met the criterion values and were included in the single function discriminating between those firms which license and those which acquire their technology by other means. The standardized discriminant function coefficients of 0.51 for size, 0.42 for product sector and 0.41 for ownership structure were remarkably close, indicating the relatively equal importance of these three factors in relationship to the decision to license. Size, however, interacted with ownership structure (Yule's Q=.785); no foreign or mixed firm was small, and only 9 of the 57 national firms were large. Ownership structure alone correlated highly with the source of technology (Q=.755), suggesting that the high correlation between size and source of technology was simply derivative from ownership. From Table 2, moreover, it is evident that foreign and mixed corporations overwhelmingly licensed their technology, even for products like paints, foundry parts, tools -- where the technology was simple and stable enough to expect that the firm could develop its own methods. From this portion of the analysis, therefore, it appeared the ownership structure was a pivotal variable influencing both the choice of product and the need to license.

This analysis enabled us to distinguish between foreign and mixed corporations, on the one hand, and state and national firms on the other. But it did not help to explain the behavior of the latter with respect to the decision to license technology. In his study of 123 Argentinian firms, Francisco Sercovich suggested that licensing permits national firms to enter oligopolistic markets in which competition is structured by the standards set through foreign imports. Licensing thus reinforces the size advantage of the firm, making competition and growth possible. In this survey, therefore, the choice of products should represent the "quality segment" of the market in which the firm chooses to compete.

Table 2. *Ownership structure, product sector and source of technology*

| | *Foreign* | | *State* | | *Mixed Pvt.* | | *National* | |
|---|---|---|---|---|---|---|---|---|
| | Lic. | Other | Lic. | Other | Lic. | Other | Lic. | Other |
| Fibres | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Plastics | 4 | 1 | 2 | 0 | 2 | 1 | 4 | 0 |
| Paints | 1 | 1 | 0 | 0 | 1 | 0 | 4 | 5 |
| Soaps | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 2 |
| Chemicals | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 3 |
| CHEMICAL | 9 | 3 | 6 | 0 | 3 | 1 | 11 | 10 |
| % of ownership category | 75% | 25% | 100% | 0% | 75% | 25% | 52% | 48% |
| Elect. machinery | 3 | 0 | 0 | 0 | 1 | 0 | 2 | 1 |
| Industrial machinery | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 7 |
| Foundry parts | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 6 |
| Tools | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 6 |
| Finished goods | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 5 |
| METALWORKING | 5 | 0 | 1 | 1 | 3 | 1 | 11 | 25 |
| % of ownership category | 100% | 0% | 50% | 50% | 75% | 25% | 31% | 69% |
| TOTAL | 14 | 3 | 7 | 1 | 6 | 2 | 22 | 35 |
| % of ownership category | 82.4% | 17.6% | 87.5% | 12.5% | 75% | 25% | 39% | 61% |

N = 90

Data on the explanations offered by firm managers in our sample for their decision to license provides some evidence for Sercovich's hypothesis, and demonstrates that neither cost considerations nor complexity are paramount. Rather, as Table 3 reveals, 51% of the firms gave "brand-name" considerations as one of the reasons for licensing, thus implying entry into a "quality segment" of the market in which standards had been set by foreign firms and foreign imports. It is also apparent from this table that for many of the firms, including many nationally-owned firms, the decision to license technology has not (as in Japan) provided the firm with a means to diversify, to fulfill the firm's expanding horizons and its growing ability to choose technology appropriate to the realization of its goals and to assimilate imported technology, adapt and extend it. Rather, the decision to license seems to have represented an unconscious choice to forego technological self-reliance from the outset. To the 51% of firms citing "brand-name" as a reason for licensing technology must be added the 30% citing "prior relationship to the technology supplier" as a factor. Indeed 12 of the 47 firms responding to this question gave no other reason but "brand name" and "prior relationship" as explanations for the decision to license. In most of these cases neither the technology nor the supplier was actually chosen by the licensor. Rather the licensor was chosen by the foreign firm, with the local firm playing a completely passive role -- one unlikely to stimulate the learning experiences necessary for technological self-reliance.

Table 3. *Stated reasons* technology was acquired through licensing*

| | Complexity+ | Prior Rel'n‡ | Brand-name§ | Cheapness‖ | Other¶ | Total |
|---|---|---|---|---|---|---|
| Total number of responses per reason cited | 25 | 14 | 27 | 12 | 8 | 86 |
| Percent of total number of responses | 29 | 16 | 31 | 14 | 9 | 99% |
| Number of firms citing this factor as one reason | 22 | 14 | 24 | 12 | 8 | 47** |
| Percent of firms citing this factor as a % of 47 firms responding | 47 | 30 | 51 | 26 | 17 | -- |

*Each firm was permitted up to three reasons.

+'Complexity of the technology' and 'the technology is so complex that only a few firms in the world have it' were regrouped under 'complexity'.

‡Prior relationship to the technology supplier either as a subsidiary of the foreign firm which would supply the technology or as a distributor for that firm's products.

§Regrouped under 'Brand-name' were responses such as 'the named product is known for its quality', 'for its brand-name' and 'need to compete with other firms with known brand-names'

‖Includes 'because it was the cheaper alternative to producing the technology themselves'

¶ Includes 'because of advantageous bargaining conditions' such as reduced costs, few restrictions.

**47 of the 49 firms which licensed their technology gave an explanation for the decision to license.

The ramifications of licensing for future technological self-reliance became evident when licensing was correlated with the managers' claims to possess the "ability to develop new product technology". Managers of firms in the survey were asked to discuss their firm's future development plans. Those managers who said their firms intended to introduce new or allied products within the next 5 years were then asked whether their firm could develop the technology it would need for these products on its own. Developing the technology was understood to include extending or modifying existing technology, copying technology embodied in machinery, or acquiring the necessary technological knowledge from books or journals. Table 4 provides data on these responses. Only 32% of the managers of those 53 firms in which new or allied products would be introduced said their firm could develop all the technology needed for these new products on their own. Twenty-five percent felt that their firms might be able to develop technology for some of these future products; 43% said they could not develop the technology on their own for any of these products but would import it. Given the uncertainty expressed by those who felt their firms might be able to develop some new product technology on their own, 'some' and 'no' answers were put into a single negative category for statistical analysis.

From Table 4 it is apparent that there is a high correlation between licensing and "the inability to develop technology for new or allied products which the firm plans to introduce in the immediate

Table 4. *The correlates of technology dependence*

| Ability to develop new product technology | Source of Technology | | |
|---|---|---|---|
| | Licence | Other | Total |
| Yes | 1( 3%) | 16(73%) | 17(32%) |
| No | 30(97%) | 6(27%) | 36(68%) |
| | 31 | 32 | 53 |

Yule's Q = 0.975

| | Product Sector | | | |
|---|---|---|---|---|
| | Chemical Sector | | Metalworking Sector | |
| | Licence | Other | Licence | Other |
| Yes | 0 | 7(88%) | 1( 8%) | 9(60%) |
| No | 18(100%) | 1(12%) | 11(92%) | 6(40%) |
| | 18 | 8 | 12 | 15 |

| | Ownership Structure | | | |
|---|---|---|---|---|
| | Foreign, State and Mixed Private | | Nat 'l Corps and Family Firms | |
| | Licence | Other | Licence | Other |
| Yes | 0 | 1(50%) | 1( 6%) | 15(75%) |
| No | 15(100%) | 1(50%) | 15(94%) | 5(25%) |
| | 15 | 2 | 16 | 20 |

future", which defines "technological dependence". Ninety-seven percen of the firms which license their technology responded 'no', whereas 73% of the firms which obtained their technology by other means respond 'yes' to this question.

This relationship, however, must be understood within the context of ownership structure and product sector. From the data on product sectors and their relationship to 'technological dependence' it can be seen that firms in the chemical industry, and especially those in high technology sectors such as synthetic fibers and plastics, are much less likely to develop their own new product technology than are firms in the metalworking sector. Only among firms in the low technology sectors -- paints, chemicals, foundry parts and machine tools -- do we find that 50% or better feel they can develop all technology for new or allied products they plan to introduce on their own.

Looked at in terms of ownership structure, the distribution of responses revealed that no state corporation, no mixed private firm, and only one foreign firm was able to develop all new product technology on its own. The exception was a foreign firm located in the chemical sector which did not license its technology. Only among national firms do we find that as many as 44% of the managers expressed the belief that their firms could develop new product technology, and there again the most important factor seemed to be whether the national firm licensed its technology or not. Of the 16 national firms which said they could develop new product technology, 15 (94%) obtained their technology by means other than licensing; of the 14 firms which could not produce any new product technology, 71% presently license their technology.

Table 4 summarizes these results and points to the central role of licensing in perpetuating technological dependence. Neither the independent direct effect of product sector nor of ownership structure was large. This relationship was also confirmed through discriminant function analysis. The standardized discriminant function coefficient for 'source of technology' was 0.834, over two and a half times larger than the coefficients for ownership (0.299) and age of the firm (0.264). Size and product sector were lower in correlation.

## Questions of Causality

But how exactly does licensing, even among national private and public firms, 'cause' future technological dependence? Three complementary and reinforcing explanations have been offered in the literature. First, it has been argued, legally binding provisions contained in licensing agreements reduce the firm's incentive to develop technology. Clauses prohibiting exports embodying the imported technology, for example, deprive the local firm of a marketing incentive which might induce further innovation. Clauses requiring the transfer to the supplier of innovations or improvements obtained through the use of imported technology remove the monetary incentive to undertake research and develop new products or processes. Examinations of licenses have shown that such agreements are replete with restrictive clauses. Decision 24 of the Andean Group was a response to this situation, and following upon its adoption government agencies in each of the Andean countries began to register and review technology contracts with a view to eliminating these restrictive clauses. Some data on the impact of Decision 24 five years after its adoption are now available, but these do not permit a conclusive determination of the extent to which the elimination of restrictive clauses alone has affected the assimilation of imported technology or the development of local R & D capabilities. Certainly the environment becomes more permissive, but merely providing an opportunity does not imply that the opportunity will be seized. Other factors undoubtedly intervene.

One such intervening variable is the psychological impact of licensing on the choice of self-reliance as a goal. Licensing, it is suggested, creates a psychological environment of dependence. Managers become accustomed to rely on imported technology, and incorporate the assumption of technology imports automatically in their future planning. The multinational corporation, moreover, does little to discourage such psychological dependence since it does not favor the growth of potential competitive centers of innovation. This hypothesis has yet to be tested in the Andean context, but it does seem plausible and is consistent with our sample results. Sixteen of the 17 firms (94%) which plan to introduce new or allied products and can develop the technology for these products themselves, not only use their own technology but have already introduced new products in the past. What this suggests is that, at least for these particular firms, the combination of these two factors -- autonomously generated present technology, sustained by the firm's experience with the introduction of new products -- appears to have contributed to the confidence which these managers expressed in their announced intention to introduce new or allied products in the future, and their assessment of the firm's ability to generate new product technology on its own.

Finally,licensing might be a factor inhibiting the development of a capacity to innovate within the firm. This inhibition results from the loss of opportunities to learn about the technology and thus to assimilate it. Firms are thus unprepared to adapt or extend existing technology in order to produce allied products or develop new product technology on their own. Two tests of this hypothesis were made. First, the extent to which the local firm's management participates in decisions about the choice of imported machinery was analyzed. Second, an attempt was made to assess the extent to which R & D activities of the kind which facilitated assimilation of the imported technology were being undertaken within these firms.

Few of the firms in this survey manufacture their own machinery. When asked the source of machinery imports, 93% (13 firms) of the subsidiaries of foreign firms which responded stated that they had obtained their machinery either directly from their parent or licensor, or from a firm recommended by their parent or licensor. Of the seven state corporations responding to this question, all had obtained their machinery imports from their foreign partner's parent or licensor or from a source recommended by their partner's parent or licensor. Only the mixed private and the national firms predominantly obtained their machinery imports from other sources. Sixty-seven percent of the mixed corporations and 80% of the national firms fell into this category.

Table 5 shows that none of the 14 firms which both license their technology and permit the choice of machinery imports to remain in the hands of the parent or licensor feel able to develop new product technology on their own. By contrast, 13 of the 17 firms (76%) which obtain their technology by means other than licensing and participate actively in the process of choosing machinery imports feel that they are able to develop new product technology on their own. None of the nine firms which license technology but which do participate in the process of choosing machinery imports felt that they could develop new product technology on their own. Participating in the process of choosing machinery imports thus appears to reinforce the self-reliance of firms which presently generate their own technology; but for firms which license, participation in the choice of machinery imports alone does not provide sufficient learning experience to enable the firm to produce its own new product technology in the future. An assessment of the research and development activities of the firms included in

Table 5. *Choice of machinery imports, source of technology and technology dependence*

| | Ability to develop new product technology | | | | | | |
|---|---|---|---|---|---|---|---|
| Choice of machinery imports | YES | | | NO | | | |
| | Licence | Other | Total | Licence | Other | Total | Total |
| Parent/licensor related source | 0 | 1 | 1 | 14 | 1 | 15 | 16 |
| Other | 0 | 13 | 13 | 9 | 4 | 13 | 26 |
| Total | 0 | 14 | 14 | 23 | 5 | 28 | 42 |

this survey suggests other directions in which the state and local firms might move to encourage technological self-reliance.

## R and D Within Firms

Of the 90 firms in this survey, only 30 both engage in R & D activities other than quality control, and expend funds on R & D apart from the operating budget of the firm. Breaking these figures down by ownership structure revealed that 67% of the foreign firms and 88% of the mixed private corporations do no R & D at all. Half the state corporations and 44% of the national corporations, on the other hand, do engage in R & D activities and expend funds for them apart from their operating budgets.

Upon further investigation, however, it was discovered that all four state firms which engaged in R & D activities were Peruvian, as were 13 of the 20 national firms which fell into this category. Whereas only 11% of the Ecuadorian firms and 23% of the Colombian firms do R & D, some 60% of the Peruvian firms engaged in research and development activities. It is probable that this high affirmative response rate in Peru reflects the impact of domestic legislation which encourages firms to engage in R & D (or in activities which can be recast as R & D) in order to recuperate the 3% tax on corporate profits used to feed a state fund for technology research. Of the 49 firms which license their technology, 65% do no R & D at all; but of the Peruvian firms which license, most do engage in R & D activities. Indeed all the foreign, state and mixed firms in Peru which do R & D also license their technology, as do six of the 13 national firms. The potential role of the state in inducing R & D activities is thus impressive.

Although these data are not by any means conclusive, simply doing R & D does not appear to have been sufficient to break the very strong link between licensing and technology dependence exhibited by the firms in this survey. Engaging in R & D when the firm presently licenses its technology only slightly reduces the probability of technological dependence. Thus, none of the 17 firms which license and do no R & D felt able to modify or extend existing technology, or to develop entirely new technology on its own for products it wishes to introduce in the future. But only one of the 13 firms which license and engage in R & D felt able to develop its own new product technology.

These results may be a function of the kind of research and development activities being pursued in these firms (see Table 6). Overwhelmingly (44%) the firms in this survey engaged in R & D of the 'product adaptation' type; for many of the respondents this often meant little more than moving a handle to a different location

Table 6. *Type of R & D activity by ownership structure*

| | | | Ownership Structure of the Firm | | | |
|---|---|---|---|---|---|---|
| | Foreign | State | Mixed | National | Family | Total |
| Product improvement | 1 ( 7%) | 0 | 1 (14%) | 7 (23%) | 4 (24%) | 13 (18%) |
| Product adaptation | 9 (64%) | 2 (50%) | 4 (57%) | 9 (29%) | 8 (47%) | 32 (44%) |
| Vertical integration | 1 ( 7%) | 2 (50%) | 0 | 2 ( 6%) | 0 | 5 ( 7%) |
| New product development | 2 (14%) | 0 | 1 (14%) | 8 (26%) | 3 (17%) | 14 (19%) |
| Process modification | 1 ( 7%) | 0 | 1 (14%) | 5 (16%) | 2 (12%) | 9 (12%) |
| TOTAL | 14 (100%) | 4 (100%) | 7 (100%) | 31 (100%) | 17 (100%) | 73 (100%) |

or changing the color of the product. Several of the firms also cited 'vertical integration', that is, increased manufacture of components within the firm, as a major Research and Development activity. Neither 'product adaptation' nor 'vertical integration' of the type described are activities with spillover in terms of building the capabilities necessary to generate future technology. One would not expect, therefore, that firms undertaking these kinds of activities would feel confident of their abilities to develop new product technology in the future. National firms which engaged in 'product improvement', that is quality control or standardization for products they produce with their own technology, and all firms engaging in 'new product development' or 'process modification', on the other hand, can be considered to have embarked upon a process of 'technological apprenticeship'. One would thus expect that those firms engaging in these types of R & D activities would feel more capable of developing their own new product technology in the future.

When the type of R & D activity is correlated with technological dependence, however, the relationship revealed is very weak. Fifty percent of the firms which engage in 'new product development' feel able to develop the technology for future products on their own. Forty-five percent of the firms which engage in 'product adaptation' also responded affirmatively to this question. A lower than expected affirmative response rate is found among firms engaging in 'process modification' and a higher-than-expected affirmative response rate among firms engaging in 'vertical integration'. The data are too scanty to say anything conclusive with respect to the relationship between type of research and development activity and technology dependence. Nevertheless, the fact that 10 of 11 foreign firms (91%) which license their technology also engage in R & D of the less innovative types (product adaptation and vertical integration), or that five (71%) of the seven national corporations which felt able to develop new product technology in the future also engage in the more innovative types of R & D activity (new product development, product improvement, and process modification), certainly indicates that this line of inquiry deserves further investigation.

## Conclusions

In this analysis a close relationship between the ownership of the firm and the products it chooses to produce was established. Ownership structure, it was suggested, was a pivotal variable associated with the decision to license because foreign, but not national, firms licensed their technology even in product sectors where the technology was simple enough to expect the firm to develop its own technology or acquire it through other means. National firms which chose to duplicate a foreign product, however, were impelled to license in order to compete in a 'quality segment' of markets in which standards were set by foreign firms and foreign imports.

Licensing, moreover, was shown to correlate highly with the intention of firms to license new technologies in the future. While legal restrictions and psychological factors undoubtedly affect the relationship between licensing and future technological dependence, a more compelling explanation might lie in the minimal participation of firms which license their technology in activities which could enhance the potential for technological assimilation or adaptation and extension of imported technology. Thus it was suggested that ownership structure and licensing interact with choice of machinery imports and with research and development activities in such a way as to produce a technological dependence syndrome in which opportunities for 'learning by doing' are consistently missed.

The study also uncovered an unexpected pattern of activities among state-controlled corporations in these three countries. While some of the firms were located in intermediate goods industries, many were located in sectors where the technology was complex and volatile and where production was consumer-oriented. In almost all instances this choice of product was such as to necessitate the aquisition of technology from foreign suppliers, and 87% of the state-controlled firms did license their technology. All seven of the state firms which responded to the question concerning choice of machinery had obtained their machinery from their foreign parent (when they were joint ventures) or their foreign licensor, or from a source recommended by their parent or licensor -- thus missing one potential opportunity for 'learning by doing'. State firms in Ecuador and Colombia, where there is no national legislation motivating them to do so, do not engage in research and development; and of the four Peruvian state-controlled corporations which do engage in R & D, all four are in R & D activities with limited spillover potential for the creation of capacities to generate technology in the future. To those who believe that state-controlled firms will automatically pursue policies of greater technological self-reliance, these results are disappointing.

These data point to certain important areas for choice by national planners. In particular, the choice of products is crucial. If technological self-reliance is to be a major objective, the selection of products for domestic manufacture must be made with a view to maximizing the potential of firms to assimilate and perhaps later to adapt, extend or improve upon the pertinent foreign technology. The appropriateness of these products to the tastes, incomes and needs of the population must also be taken into account, of course. The sectors in which state-controlled firms in this survey were located were obviously not chosen with these factors in mind.

Considerations of appropriate product sectors, of depackaging technology in order to participate in the making of decisions which enhance technological capacity, and of developing R & D activities which facilitate the assimilation of imported technology and the generation of more appropriate technologies must also be assessed by governments when they encourage multinational corporations to locate wholly or majority-owned subsidiaries in their countries, or to enter into joint ventures with local firms. The data contained in this study suggest that only corporations in which 80% of the shares are owned by nationals diverged significantly in their behavior from the foreign and mixed corporations, and followed policies conducive to creation of some potential for technological self-reliance. This puts seriously into question the present policy of divestment as a solution to the problem of technological dependence within the Andean Group.

[Extracted from "Licensing and Technology Dependence in the Andean Group", World Development, Vol. 6, No. 4, April 1978, pp. 447-57. Copyright © Pergamon Press Ltd., Oxford, England.]

# Intermediate Technology in China's Rural Industries

Carl Riskin

[China's rural industries, which make extensive use of intermediate technologies, fulfill a number of different functions, some strictly economic and others more socio-political in nature. After a brief history of rural industrial development since 1952, this paper identifies the most important functions, and the main results of Chinese experience. Given China's objectives, its rural industries seem to have been developed in a manner appropriate to existing conditions and to the tasks they were intended to accomplish; but their role is now shifting.]

In an age of remarkable technological feats, it is natural that great stress should be put on the search for technological solutions to the problems of less developed countries. In pursuing technologies suitable to the factor proportions, foreign exchange availabilities and skill levels of developing countries, it must not be forgotten that technology interacts in a complex variety of ways with other components of culture and society, and that these relationships play a role in determining the appropriateness of particular techniques. The history of China's experiences with the search for appropriate technologies is of interest in this connection. Because the Chinese have gone to unusual lengths in developing indigenous and intermediate techniques in industry, their experiences shed light on the complexity of issues affecting the evaluation of such techniques, and also provide some insight into the size and the limits of their potential contributions to accomplishing such targeted objectives as increasing employment and output, reducing capital requirements, and saving foreign exchange.

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## A Brief History of Technical Choice Policy in the PRC

A coherent general approach to industrial development was articulated in China shortly after the establishment of the People's Republic, and was incorporated into the First Five-Year Plan (1953-57, but published only in 1955). According to this approach, while the central government was busy building a modern, large-scale industrial sector to serve as the backbone of the industrialization effort, the various localities (provinces, municipalities, districts and counties) were to undertake an effort of their own. Their task was primarily to produce industrial inputs for agriculture and consumer goods required by the peasantry, and secondarily to serve as adjuncts to the emerging modern industries in the cities.

The technologies to be adopted by the local industries were dictated by a constraint central to the entire approach, viz., that these industries use only such resources as were not required by the modern, large-scale sector. Under no circumstances were they to compete with the modern sector for raw materials, fuels or other inputs. Hence, they were to be confined to waste and scrap materials, secondhand machinery and equipment, small scattered or low-quality ore deposits, and locally available skills and financial resources. The technologies consistent with this constraint were relatively small in scale of output, and relatively labor-intensive. Hence the administrative division of Chinese industry into centrally and locally operated components conformed quite closely to the technological division between relatively large-scale and capital-intensive units on the one hand, and relatively small-scale and labor-intensive ones on the other. A large part of the latter category, strictly speaking, consisted of handicrafts and was under collective (i.e., cooperative) rather than local government jurisdiction.

During this period, the peasantry depended for a major portion of its production and consumption needs upon the local industrial and handicrafts sectors. The First Plan called for most investment in agriculture to be self-financed by the agricultural cooperatives and individual peasant households; local industry and handicrafts were the natural source of the real goods counterparts to local savings. But with its leadership resources stretched thin by a variety of massive economic and social programs of higher priority, the government did not vigorously promote local industrialization at this time, and farm production lagged. The government became aware of these problems by the middle of the First Plan period, and began to encourage greater attention to local industries. In 1957 the central ministries worked out a set of more than 100 designs for small-scale plants capable of being maintained and operated locally. Their importance was to emerge only later, for shortly after their appearance they were caught and temporarily inundated by the advancing wave of the Great Leap Forward movement (1958-60).

The movement had as one of its chief characteristics the rapid establishment (within a year or two) of literally tens of thousands of small enterprises, many no more than workshops or sheds, under the administration of the newly formed people's communes and their sub-units (production brigades) and of the local governmental bodies directly above them. By mid-1960, according to one report, there were about 60,000 industrial units run by the counties (*hsien*), an average of about 30 such enterprises per county, and some 200,000 units run by the rural communes, not including the even smaller shops of the brigades. These industries included iron and steel, non-ferrous metals, coal mining and refining, electric power generation, agricultural tools and machinery, chemical fertilizers, construction materials, light industries of various kinds and transport and communications.

Outside China, today's judgments on the Great Leap's small-industry experiment tend to be harsh. The movement was indeed laced with flaws: local resource bases and market conditions were not adequately investigated before construction; objective technological constraints were not observed; necessary production of small tools, utensils and household articles fell away as handicraft equipment and raw materials were commandeered by the new factories to make iron and steel and other heavy industrial goods; commune enterprises used their substantial financial freedom to make high profits by gearing production to the demands of materials-short urban factories, ignoring the pressing needs of their own peasants who could not meet such competition. The resulting acute shortages of small commodities, inferior quality, great waste of materials and equipment and an unsound drain of labor away from other activities -- especially farming -- called for rapid rectification.

Despite these grave weaknesses, the small-scale industry movement of the Great Leap period had some substantial positive effects on the country's development. Many of the thriving regional industries of the 1970s had their origin in a primitive workshop established in 1958. The idea of dispersed, small-scale, locally operated and indigenously equipped industries responsive to the needs of the localities was in many areas so good, and the enthusiasm so great, that the enterprises established transcended their obstacles and became viable. Even where the shops established during the Great Leap were forced to close, however, the initial experience with industrial methods they had afforded the peasants and the lessons, both positive and negative, to which they gave rise, proved invaluable later when local industrialization was again pushed vigorously.

The general errors in planning and organization that characterized the Great Leap Forward were accompanied by three successive years of harvest failure, and by the emergence of the Sino-Soviet dispute with the withdrawal of Soviet experts from China in June

1960. These conditions, which caused a sharp downturn in industrial and agricultural production in 1959-60, necessitated a consolidation of local industries in which the majority of the new small enterprises were dismantled. During this period policy toward small-scale local industry became the focal point of vigorous political debates between those who regarded such industry as unruly, uncontrollable and a hindrance to effective central planning, and those who saw it as a means of mobilizing local resources, arousing local initiative and combatting bureaucratism. The former charged that "those people claiming reliance on their own resources actually impair the State's interests and thwart the completion of the planned projects and the smooth progress of production". Later, during the polemics of the Cultural Revolution in the late 1960s, the mass closures of small industries in the early part of the decade was blamed exclusively on the political motivations of officials who opposed local control. There is indeed evidence of political opposition to local industrialization at this time, but there were also strong economic reasons for the mass closures that took place.

Nevertheless, despite the closures, a good many of the leap-originated enterprises survived or were restored when economic conditions began to improve in 1962. The Chinese press of this period is replete with examples of localities with flourishing small and medium industries even in backward areas, such as Kansu Province in Northwest China, which had not been able to make its own nails in 1949, but which had some 70 farm equipment factories in 1963 (compared with 5 in 1957, before the Great Leap) producing chemical fertilizer, cement, water pumps, diesel engines and insecticide sprayers. In the economically advanced regions of the country, development of small industry was more extensive. While the impetus of the Great Leap years was certainly lost, the level and growth of small industrial activity in the early 1960s was undoubtedly far greater than in the years preceding the leap. Just as important, these industries were on a much firmer basis, producing goods that were locally needed at costs not unreasonably high, and without the waste that had characterized such great leap phenomena as the 'back-yard iron and steel' units.

It was from this relatively sound foundation that rural industrialization entered a dramatic take-off phase during the Cultural Revolution in the late 1960s. Under the stimulus of that movement's encouragement of local, decentralized initiative, and with the more cautious central planners under attack, various provinces and *hsien* began to report growth rates for local industries of a magnitude that had not been seen since the Great Leap. The new industries were closely linked to agriculture. For example, the production capacity of small nitrogenous fertilizer plants -- a sector that had already grown considerably during the early 1960s -- increased by 5 times between 1965 and 1969. The share of local plants in national fertilizer output rose from 12% in 1965 to over one-third in 1969, to 43% in 1970, to 60% in 1971.

Local industrialization in the years preceding the Cultural Revolution centered on chemical fertilizer and cement production, the manufacture and repair of farm equipment and machinery, and farm products processing industries. These continued to be stressed in the spurt that began in the late 1960s, but they were joined by a rapid spread of local power industries (hydroelectricity and coal) and of local iron and steel production. The latter industries provided a producer goods base for local self-reliant development far more extensive than had previously existed. The number of small hydroelectric stations built in the two years 1970-71 was said to exceed the total for the previous 20 years; by early 1972 there were some 35,000 such installations in China providing 16% of the total national installed hydroelectric generating capacity. The rapid extension of electricity to areas previously without mechanical motive power was of great importance in "forcefully stimulating the development of local industry". For example, in the much publicized Lin *hsien* of Honan Province, the extensive development of some 244 county- and commune-run industries had to await the coming of electricity with the completion of the famous Red Flag Canal in the late 1960s.

Iron and steel had been perhaps the major victims of the closures of small plants in the early 1960s, and there was no evidence of any significant revival of this local industry until the end of the decade, when county-run blast furnaces began to go up in numbers, turning out 3 times as much pig iron in 1970 as in 1969. By 1971, all provinces, municipalities and autonomous regions except Tibet had their own small and medium iron mines and iron and steel plants, which were responsible for one-fourth of the iron ore and one-fifth of the pig iron produced in the nation. The erection of numbers of small and medium-scale oxygen top-blown converters brought a rapid increase in steel production in many provinces. The development of this industry on a local basis was significant: it released the local machine-building and other industries to some extent from the need to obtain scarce centrally produced iron and steel.

Thus, from the late 1960s on, rapid development of the "five small industries" (iron and steel, cement, chemical fertilizer, machinery, and power) provided the basis for relatively comprehensive "local industrial systems", whose components had tight backward and forward linkages with each other and collectively with agriculture. These "small but complete" systems were most often at the level of the *hsien*. Their completeness was relative; while striving for self-reliance, they sought and received aid from higher levels in obtaining a certain irreducible minimum of sophisticated equipment, technical assistance, and sometimes investment funds. Their erection was aided by the politics of the Cultural Revolution, and by a run of consecutive good harvests that provided raw materials as well as local savings to mobilize.

The speed of local industrialization decreased after 1972, as the local networks filled out in those areas of the country most advantageously situated with respect to raw materials and markets, and perhaps as a more central-control-oriented leadership exercised authority.

## Functions of Intermediate Technology

Rural industries using intermediate technologies produce only a small share of aggregate industrial production. Much of commune, brigade and team non-agricultural activity is still of a handicraft nature. The rural collectives produce most of the national collectively produced industrial output, which, according to one report, constituted 14% of total industrial output in 1973. Only at the level of the commune is a substantial portion of this production carried out by industrial (as opposed to handicraft) methods. Above that, the counties are the major locus of intermediate technologies. Thomas Rawski estimates that the "five small industries" under county jurisdiction together produced about 6% of the gross value of factory production in 1972. Adding the output of county-run farm products processing plants and commune-operated factories, an impressionistic estimate of the size of the entire rural sector using intermediate technologies would put its output at about 10% of China's factory production. While small, this is not insignificant, approximating the entire industrial output of the country in 1952.

The importance of this sector to the Chinese economy is greater than its proportion of aggregate output suggests. The principal constraint to industrial expansion in China has been the growth of farm output. The key to stimulating the latter is to equip agriculture with new, high-yield seed varieties, which in turn require increased supplies of chemicals, water and (especially in some localities) machinery. Directly responsible for accomplishing this task are those industries most characterized by intermediate technologies. The provision of increased and regularized water supplies, for instance, requires large quantities of cement for water control construction. The share of small plants in national output of cement has risen steadily to 50% or more, at the same time that national output was itself growing rapidly. The number of small plants increased from about 200 in 1965 to 2800 in 1973. Similarly, the realization of increased yields from old and especially new varieties requires heavy additions of plant nutrients, and the chemical fertilizer industry has been one of the most rapidly growing industries in China since the early 1960s. The share of small plants in this industry grew to 60% in 1972, then dropped back to about 45% in 1974 as substantial investment in large-scale plants began to bear fruit. It appears that the bulk of all but the heaviest farm machinery and equipment is produced by local small and medium plants. We have already indicated the importance of small-scale production in the power and the iron and steel industries. So, it is the sectors with particularly close forward links with agriculture that are distinguished by a substantial reliance on intermediate technology, and this is also true of food processing.

A convenient way of getting at the more important economic characteristics of intermediate technologies in China is through an examination of the national applicability of the general arguments that have been made for such technologies. This method has the advantage of providing insights into the relevance of the general propositions -- at least to the case of China, and possibly beyond. The arguments considered here fall into six categories.

(a) Employment creation: In countries with much unemployment or underemployment and with small capacity to produce -- and limited foreign exchange to import -- capital goods, the development and use of intermediate technologies will permit the absorption of more labor than would more advanced methods, while still permitting substantial increases in productivity.

The intermediate technologies in use in China's rural industries clearly are more labor-using than the advanced technologies of the urban modern sector. In the technically flexible agricultural machinery industry, for example, complex machine tools often operate under the same roof as workers casting and assembling by hand. Food processing is similarly labor-intensive in comparison with modern urban plants; but the net impact of the development of rural food processing factories on the rural labor market has been to increase labor *supply* by releasing countless individuals (mostly women) from the arduous tasks of hand grinding and milling. In the small-scale cement and chemical fertilizer industries, the technical coefficients of the main production processes are more rigid, so that labor-intensive adjustments are largely confined to ancillary processes such as materials handling and transportation, and to the construction and enlargement of facilities.

In sum, despite the relatively labor-intensive character of the small rural industries, their direct labor-absorbing impact has been small. Sigurdson has estimated that in Hopei Province in 1973, for example, rural industries employed in permanent year-round posts only about 2.5% of the labor force, and in seasonal or temporary industrial jobs another 2.5%, for a seasonal peak total of 5% of the labor force. In the counties visited by the American Rural Industries Delegation, from 4 to 8% of county labor forces were engaged in rural industries at their seasonal peaks. Moreover, not all of these workers are net additions to the industrial work-force, since some were originally handicraftsmen who were tapped for factory work because of their skills or when their shops were upgraded into factories.

The small direct labor-absorbing effect of rural industries is regarded in China as an accomplishment rather than a failure. The planners definitely do not strive to make these industries employment creators. Quite the contrary; and since the surge of rural industrialization in the late 1960s they have put strict limits (which probably vary by county) on the proportion of a county's labor force that may be industrially employed. They strive constantly to mechanize technologies, often in labor-saving ways. Most areas of China have traditionally experienced labor shortages in one or more peak agricultural seasons during the year. With the advent of large-scale water conservancy and farmland capital construction work in the 1950s and 1960s and the spread of high-yielding rice and other plant varieties throughout large areas of China, the peak seasons have multiplied to occupy a much larger portion of the year, and substantially more labor than before has been demanded at any given season. Rural industries, by playing a major role in equipping the communes with the cement, fertilizer, insecticides, and pumps required to adopt new and more labor-absorbing farm technologies, have thus helped to limit the farm labor surpluses available for their own expansion.

Thus, the main employment-creating effect of China's rural industries has been the indirect one of counteracting the diminishing returns to labor-intensive cultivation by providing agriculture with modern types of inputs that are complementary to labor. The success of this indirect employment-creating role has constrained the direct absorption of labor by the small industries. For the last several years, it has been clear that further growth of rural industrial output will have to come chiefly from increased productivity, at least in the near future.

(b) Differences in factor markets and social costs: Variations in factor price ratios can lead to the adoption of different techniques in different regions or sectors of the economy. In China, of course, factor prices are fixed by the state, and their relation to real relative scarcities is often not readily apparent. Regional or urban-rural differences in nominal relative factor costs may be as much a result as a cause of policy. There are, however, identifiable forces acting on factor prices in such a way as to enhance the attractiveness of relatively labor-intensive technologies in rural and small town areas.

Average wages for regular workers in county factories appear to be only about three-fourths as high as those in factories run by the center, the provinces and major municipalities. In the industrial enterprises operated by communes and brigades, wage levels are determined by collective rather than state policy, although subject to state guidelines. In some of these units permanent workers receive fixed monthly wages, usually lower than those in county factories, but the more common practice is to allot them workpoints as is done with agricultural workers. Their incomes are then determined by the size of the annual net income earned by their collective. The recommended practice is to set the workpoint values of commune industrial workers so as to enable them to earn somewhat but not much more than the average peasant. Temporary workers in these factories are usually paid in the latter fashion. As for temporary workers in county factories, the county may pay them part of their wage directly and send the rest to their home brigade, where it will serve to swell the workpoint value for them and their fellow brigade members.

Thus, in the collective industrial enterprises, wage levels are geared to be slightly higher than average incomes in agriculture, and they are somewhat higher in county industries. But it should be kept in mind that living costs are a good deal lower in rural areas than in large cities, and that the skill level of the workers is substantially lower in the former. How much difference in real wages per unit of equivalent labor remains after discounting for these considerations is unknown.

If one focuses on social costs per worker: to bring a rural inhabitant into one of the urban locations of modern industry would entail substantial infra-structural costs in providing housing, transport and sanitation facilities, etc. In the communes and county seats, however, workers often continue to live in their villages and require little or no such investment. The opportunity cost of their industrial employment is minimized in that they are available for agricultural labor during the heavy seasons, as they would not readily be once moved to a large city. Clearly, rural location enhances the flexibility needed in an economy still heavily dependent upon the seasonal demands of agriculture. It should be pointed out, however, that while China has acted to prevent the further expansion of the biggest cities, intermediate towns and cities are continuing to grow quite rapidly, and the social costs of expanded employment in such medium-sized urban areas are apt to be quite high.

If labor tends to cost less in rural areas, the costs of using sophisticated and expensive capital equipment are undoubtedly higher there in the absence of developed power, maintenance, skilled labor and transportation facilities.

(c) Overcoming rural transport limitations: Despite considerable improvements in China's transportation system, much of the vast hinterland is still served only by poor roads or footpaths. Away from the railroad or a navigable waterway, transport costs escalate rapidly, particularly for items of high bulk-to-value ratio. For example, in one county a 25-mile haul by truck raised the price of coal by 50%. Under these conditions, to transport locally available raw materials to central, large-scale production facilities and then haul the products back to the localities for consumption would be extremely costly. Where transport costs are high, therefore, it will be cheaper to produce locally on a small scale, and to use technologies whose avoidance of long distance transport costs more than compensates for their relatively high production costs.

This factor is undoubtedly a major part of the reason for the attention given to small rural industries in China. It is most apparent in the cement industry. Jon Sigurdson has shown that, based on the cost of truck transportation in Hopei Province in the early 1960s, a centrally-located rotary kiln cement plant producing 288,000 tons annually for distribution to 9 surrounding county seats would have to incur production costs about 18% lower than the hypothetical alternative of each county establishing its own 32,000 ton vertical shaft kiln plant, in order to overcome transport cost disadvantages. He doubts that the difference in production cost is that great. The American Rural Industries Delegation was told that a small plant in Shansi Province was able to provide cement at 25% lower cost per ton than the delivered cost from the nearest modern plant.

Poor rural transport facilities figure in less direct ways as well. For example, much of the nitrogenous fertilizer made by China's small plants takes the form of ammonium bicarbonate. This product deteriorates rapidly and therefore must be used soon after production. Clearly, where transportation is time-consuming, it is advisable to locate plants near the points of use. Given the product and the transport constraint, local small-scale production appears quite rational.

In the agricultural machinery and equipment industry, greater responsiveness to widely varying agricultural conditions is often cited to explain the emphasis on small and dispersed local production. To some extent this is because it is felt that local people best understand their own conditions and are culturally more sensitive to the demands of their neighbors. But the argument is certainly strengthened by the physical difficulty that would be faced by personnel in large urban factories who attempted to study at first hand the problems of customers in remote and inaccessible villages.

The rural transport constraint, then, appears to be a substantial part of the explanation for China's emphasis on rural small-scale industrialization. As the rail network expands and roads are improved, this factor will diminish in force. Consolidation, enlargement and technical improvement of the rural plants can be expected to accompany this process, as they indeed already have. But there will still remain other reasons for the continued reliance on intermediate technologies in a range of industries.

(d) Concern for savings, and farm labor demand: The possible links between the savings rate and the choice of technique may be stated as follows: technical choice influences the distribution of income, particularly as between wages and profits. If the propensities to consume out of these two forms of income differ, then the savings rate will vary according to the choice. If the existing rate of saving is regarded as too low, and political or technical considerations constrain the use of other instruments to increase it, then the choice of technique may be made contingent not only upon the size of the resulting output but also upon the amount of saving generated for future growth. [Note: A mathematical model used to show how technologies affect total saving under different assumptions is omitted here.]

It is difficult to say whether Chinese planners regard the savings rate as too low and use technical choice policy as a means of raising it. The aggregate rate of saving is quite high in China, upwards of 25% of national income. There is evidence that local planners seek to raise financing for investment in heavy industries by attracting consumers with new kinds of factory-produced consumer goods that sell at high prices, earning substantial profits for the state. These profits are necessary to subsidize losses frequently made in local production of heavy industrial goods, particularly iron and steel. It is not unlikely therefore that local planners choose techniques with an eye to minimizing losses in heavy industrial production and increasing the profitability of light industrial lines.

If this is indeed the case, then it becomes relevant to inquire into the difference in saving rates between wage earners and profit recipients. Sen points out that such a difference "is likely to be spectacularly true in a socialist economy, where the profits are earned by the state", and China is certainly a case in point. State enterprise profits account for the great bulk of state revenue, which in turn constitutes the largest contributor to aggregate savings. With respect to wages in rural industry, we have also seen already that the real wage per unit of equivalent labor is somewhat but not much lower in county-run industries than in the modern sector proper. In commune industries wages are lower, but still designed to be above peasant incomes.

So far, the parameters examined suggest (it is hardly more than a suggestion) that China should be moving away from the most primitive, labor-intensive techniques in rural industries toward greater capitalization and technical sophistication. There still remains, however, the difference between savings rates in agriculture and industry. This gap is probably not as great as might at first be suspected, for two reasons. First, the collective organization of the commune and its sub-units probably goes some distance toward eliminating the "isolation paradox", under which individuals acting only for themselves are unwilling to save as much as they would on the assurance that everyone else saved more as well. Second, collective savings decisions are closely tied to investments, the fruits of which are easily perceived by members of the collective, providing a strong incentive to stimulate collective saving.

Despite these considerations, there undoubtedly remains a significant difference in savings rates between agriculture and industry because of the differences between these sectors in *per capita* product, personal incomes, and the relative propensities to save of state organs and collectives. There is no evidence, however, that such savings differences are a serious factor in the choice of industrial technique. On the contrary, Chinese statements on local industrial policy often caution strongly against building or enlarging rural industries in such a way as to affect agricultural output. Further, there is a limiting factor of importance, namely, the dependence of rural industries as a whole upon agricultural raw materials, which have been periodically the operative constraint to their expansion. Without adequate increase in agricultural output, the higher savings *rate* in industry becomes irrelevant since industrial production itself is stunted.

China began its extensive experiments with rural industry in 1958 using extremely primitive techniques, such as the famous "backyard iron and steel' sheds. An early cement factory resorted to hand crushing of raw materials, cost a mere ¥1000 to build, and produced nine tons per year. The considerations highlighted by the model of this section suggest some (by no means all) of the reasons why the Chinese should have been moving toward larger scale and greater technical sophistication in their rural small industries. That such movement has occurred and is continuing at present, has been noted by virtually all observers. [Comment: the move toward "modernization" has accelerated since this article was first written.]

In the local cement industry, as an example, a wide variety of different scales of production and levels of mechanization are in use today, from commune plants with small, manually operated, egg-shaped kilns that produce a few hundred tons per year, to large vertical-shaft kilns embodying fully automatic charging and discharging operations and producing up to 50,000 tons per year. Standard plant designs supplied by the government provide for kilns ranging in annual production capacity from 7000 to 44,000 tons. None of the technological variants are new or unknown outside China; aside from local adaptations, they conform to methods abandoned in the industrialized countries since the early 1920s. (Few of China's intermediate technologies are really new; rather, they are known and have been abandoned as obsolete or uneconomical elsewhere.) The rural cement industry in China today is quite capital-intensive, especially in comparison with its primitive Great Leap origins. The standard model for a small county-level plant with a capacity of 32,000 tons involves an investment cost per worker of ¥3350, some six times the annual wage of its workers. This, too, is characteristic of the general direction of Chinese rural industries currently. Thomas Rawski estimates that the capital-intensity of the core processes in China's county-level rural industries today does not differ greatly from that of large Chinese plants in the 1950s.

Finally, despite the existence of standard plant designs, the typical story of individual plants visited by foreign observers or written about in the press is one of small and primitive beginnings followed by constant expansion and modernization as technical skills develop, market demand increases, capital equipment becomes accessible or cheaper, and as labor supply tightens. This too, seems typical of other rural industries. Of course, other factors help explain the increasing capital-intensity and sophistication of China's intermediate technologies. However, the growing demand for labor in agriculture brought about by land-augmenting technical change, and the desire to capitalize on higher reinvestment rates afforded by more capital-intensive techniques are probably among the most significant causes.

(e) "Walking on two legs": So far we have been concentrating almost exclusively upon the intermediate technologies of the rural industrial sector, without explicitly recognizing the existence of a modern sector with large-scale plants and highly capital-intensive technology, which produces the great bulk of China's industrial output value. We have noted rural transport constraints; but China's deliberate pursuit of a policy of technological dualism rests upon more than transport bottlenecks, important as these are. Mao-Tse Tung's "walking on two legs" directives, such as "It is better for the initiative to come from two sources than from only one", suggest a positive motivation for such a policy. In fact, China has never considered foregoing the rapid development of a modern, large-scale 'backbone' industry, and intermediate technology has always been considered a supplement to, not a substitute for, this sector. The belief has been that some opportunities for development would be missed if the localities were not encouraged to build industry on the basis of the more primitive technology available to them.

The basic assumption behind this belief is that there exist throughout the country many kinds of resources, from the intangible but important local initiative (discussed further below) to scattered or low-grade mineral deposits, small streams for generating hydroelectricity, and waste or scrap materials from larger plants that are of no use to the modern sector. Such resources can be used to produce locally needed articles, especially inputs and equipment for agriculture, thus supplementing the output of modern industry which is constrained by shortages of high-grade fuels, raw materials, skills and foreign exchange. An essential corollary of this rationale is of course that the intermediate sector does not further constrain modern industry by competing with it for factors of production.

This rationale for intermediate technologies, which is quite independent of the other explanations discussed so far, is explicitly emphasized in virtually all Chinese policy statements on the subject. It also has two observable implications that we may look for in the behavior of small industry in China. First, as industries utilizing intermediate technologies reach a scale at which they exhaust their specific and non-competitive resource base, they must either 1.) cease to expand, or 2.) be taken over by the modern sector, leaving their previous function to more primitive newcomers. This appears to have happened on a wide scale in the early 1970s as a result of the rapid growth of rural industries stemming from the Cultural Revolution years. It can also be observed in individual enterprises, as they outgrow their local resource base or market.

For example, Tsunhua county's iron and steel plant became subject to provincial control when, as a result of expansion, it began to receive investment in the form of steel rolling equipment and large-scale electrical machinery from the province in 1972. At this point, both its investment and its output became part of the state plan at the provincial level, the allocation of both becoming a provincial responsibility. In the case of the Hui county Cement Plant of Honan Province, a plant that was built in 1964 with only one egg-shaped kiln producing 4 tons per day, had by 1975 added 9 additional kilns, including one automatic vertical shaft kiln, and was producing 400 tons per day. But this plant had recently had a substantial labor force reduction, and its 6 egg-shaped kilns were standing idle. Moreover, it had given up its original name, Peichuan, because the local commune of that name had established its own cement works (as had five other communes in the *hsien*). This enterprise may have been reaching the end of its ability to expand within a purely local context.

The other implication of the 'walking on two legs' model is that, as the constraints limiting expansion of the modern sector are removed, some of the needs previously met by the intermediate sector become subject to more efficient fulfillment by modern industry. It is probably premature to look for widespread evidence of such a phasing out of local intermediate technologies in China so soon after a period of their rapid expansion, but one clear example of it can be seen in the chemical fertilizer industry. Here, as we have seen, the proportion of total output produced by small plants dropped from 60% in 1972 to about 45% in 1974 as a result of substantial growth in large-scale productive facilities benefiting from economies of scale, and producing a fertilizer with high nitrogen content and less problem of deterioration. In 1971-74, China contracted to purchase 26 chemical fertilizer plants from abroad, including 13 very large urea plants from Western European, Japanese and U.S. firms. As more of these plants have entered production, it is likely that the small-scale sector has undergone further relative decline.

China's nitrogenous fertilizer industry contains one of the few Chinese examples of a new intermediate technology, and the 'walking on two legs' reasoning explains its use quite well. Ammonium bicarbonate is a principal product of the rural fertilizer plants, although it is used nowhere else in the world as a fertilizer. Its advantage lies in its constituting a relatively inexpensive and simple method of taking advantage of small, local supplies of coal, lignite, methane or other sources of hydrogen, to produce a usable solid fertilizer. Its disadvantages are a relatively low nitrogen content (17.5% as compared with urea's 46% nitrogen), and a tendency to lose amonia rapidly during storage and transportation. Hence its large-scale production in centralized locations far from ultimate use is out of the question. But its value when produced in small quantities with local materials for prompt use on adjoining fields is substantial.

Thus, the technological dualism of 'walking on two legs' would seem to have some solid economic advantages at this stage of China's development. Of course it is pursued for additional reasons as well, and these are best taken up in the context of our final category for analyzing China's intermediate technologies, the quest for self-reliance.

(f) Self-reliance: The literal meaning of the Chinese term for self-reliance, "regeneration through one's own effort", conveys a more accurate meaning than that of autarky frequently associated with this term. Self-reliance is related to 'walking on two legs' in that it constitutes the framework of motivation, political work style, and inter-unit economic relations that should promote the exercise of initiative by each leg. The most obvious economic objective of self-reliance at the local level is the development of local industrial production on the basis of those resources locally available. But the notion of self-reliant development has other aspects to it besides immediate output growth.

First, it is designed to stimulate initiative by placing the political responsibility for undertaking development planning with the individual counties and communes themselves. It frowns upon the passive stance of waiting for the central authorities to arrive with aid. At the same time positive incentives are provided in the minimization of bureaucratic hindrances to local efforts, and in permitting the units involved to retain the bulk of their profits as long as operations remain strictly local. With this kind of encouragement, it is clearly in the interest of local populations to support rural industrialization programs. The kinds of technologies involved are installed quickly and begin paying off in dramatic and easily perceived ways: telephone poles erected, electric lights becoming available, more fertilizer for the fields, labor-saving machinery, canned and bottled fruits and vegetables for the table, and money from the higher incomes to pay for cooperative health insurance and better commune schools. There is little doubt that the rural industrialization of the past decade originated in local enthusiasm; however, much of it was stimulated by centrally sponsored ideological campaigns and Tachai-type models.

If the center's primary role is the educational one of demonstrating how self-reliant development can be undertaken, it also plays an important supportive role financially and technologically. The national government's fiscal relationship with the provinces has been shown to be a highly redistributive one. The most developed provinces (and province-level municipalities) such as Shanghai, Liaoning and Kaingsu remit to the central government 70-90% of their provincial revenues, while the poorer provinces keep their entire revenues and receive central subsidies as well. It would seem that some such redistribution occurs at the intra-provincial level also. Thus, those poor localities most disadvantaged in building industry can get assistance from their provincial or regional government that would not be available to others.

That such assistance takes place does not contradict the principle of self-reliance. Like matching grants elsewhere, it can be a spur to greater local efforts. A county, knowing that it will qualify for aid from its province if it can reduce the need for external assistance to a few pieces of key equipment beyond its own production capacity, will have a greater incentive both to initiate the effort and to limit its demands on the higher level. Thus, in most small plants, although the proportion of self-provided equipment is high, there is some element of machinery supplied by a technologically superior level. or even imported. This is perhaps most systematically noticeable in the rural chemical fertilizer industry, much of whose equipment has been provided by Shanghai factories.

Technical assistance is also provided by the center. The basic designs for small industries originate with central research institutes, whose technicians frequently travel to the rural areas to study their problems and give assistance. Modern factories provide advice as well as discarded equipment to their rural counterparts. The center also plays a role in allocating skilled labor emerging from the universities and technical institutes. Without these kinds of intervention by higher levels, self-reliance would have strong centrifugal ramifications, with localities in the most favored regions and those boasting a higher original industrial base growing away from the less fortunate areas. It is probable that this has occurred, despite the state's redistributive role, in absolute terms -- i.e., that the absolute growth in local industrial production of richer regions has exceeded that of poorer regions, even if *relative* growth rates have been higher in the latter.

Self-reliance of course also speaks to other objectives in the official 'social welfare function' besides the purely economic ones discussed above. For example, the goal of preventing excessive urbanization is a complex one, requiring not only administrative controls on migration but also the creation of a dynamic momentum in rural areas, involving new employment opportunities, changes in cultural facilities, changes to use newly acquired skills by young people emerging from high schools, etc. The development of rural industry is an essential link in this chain. Similarly, the organic link between rural industry and surrounding agricultural activities is partly designed to counter the "contradiction between industry and agriculture" and "consolidate the worker-peasant alliance". Thus, commune industrial workers, whose incomes are close to those of their peasant neighbors with whom they continue to live and even work during the heavy season, will be less likely to develop a sense of superiority and privilege that makes them insensitive to the concrete needs of the farm population and to the low general income level of the country. Local self-reliant industrialization is also regarded as a safeguard against the excessive concentration of bureaucratic power at the center, and was explicitly defended in those terms during the Cultural Revolution. The more even spread of economic power throughout the country has inevitable consequences for the distribution of political power as well.

Finally, self-reliance involves dynamic externalities that are important to any developing country or region. The generation of knowledge, experience and skill that accompanies the local production of a machine is obviously far greater than the similar characteristics attached to one imported from abroad or purchased from a distant city. In this respect, the agricultural machinery industry in particular has been responsible for the training of thousands of workers and the education of their neighbors with regard to industrial techniques.

## Conclusion

In working through the various perspectives for understanding the objectives of China's rural intermediate technologies, we have proceeded from some very specific goals, such as job creation and the circumvention of transport constraints, to some very broad ones, such as narrowing the urban-rural gap and resisting bureaucratization. Ultimately, even the most general objectives reverberate in the sphere of production, and it is extremely doubtful that China would pursue a set of socio-political goals which had severe negative implications for economic growth. Nevertheless, the range and complexity of relevant considerations, as well as of the technologies adopted themselves, makes any summary judgment of the optimality of China's approach difficult.

After two decades of honing and adjustment, however, the intermediate technologies of China's rural areas do seem to be accomplishing their various objectives, judging by published accounts and the growing volume of travellers' reports. It is difficult to conceive of an alternative strategy that would not sacrifice some of these goals in the service of others. In fact, given the constraint posed by the development of agriculture, and the problems encountered in the 1950s with overcentralization of control over industry, it seems unlikely that a policy of putting even more emphasis on the modern large-scale industrial 'leg' would lead to faster growth of national product, or even of total industrial output. Therefore, on the basis of the evidence available, it is reasonable to conclude that China's rural intermediate industrial technologies are appropriate to the conditions in which they exist as well as to the tasks they are intended to accomplish at the current stage of development.

[Extracted from World Development,
Vol. 6, No. 11/12, November/December
1978, pp. 1297-1309. Copyright ©
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# Case Studies of Technology Sharing By U.S. Firms in Algeria and Brazil

**Jack Baranson**

[Recent economic trends have induced some U.S. companies to more actively transfer to other countries relatively sophisticated technologies and the ability to use them. Technology buyers are gaining in bargaining power. Two cases of technology transfer contracts of U.S. firms, with Algeria and Brazil, are examined, indicating advantages seen by both sides.]

Certain trends in the world economy have compelled a number of U.S. corporations to alter their mode of foreign involvement and to revise policies governing the management of their technological assets. In these changing circumstances, U.S. firms are finding new opportunities to earn returns on their managerial and technological assets. In some instances, the "product" they sell has become the implanting of design and engineering capabilities in foreign countries. Technology purchasers face new sets of options and opportunities for acquiring foreign know-how, usually on more favorable terms.

Changes in corporate perspectives. From the corporate perspective, the attractions of equity investment in and managerial control of foreign facilities are decreasing. A growing number of U.S. firms have decided that the risks associated with overseas capital investments have become too high for the realized rates of return. Aside from political uncertainties in a widening area of the world, there are economic vicissitudes brought on by world inflation, exchange rate revaluations, and recessionary cycles, all of which have added to the risks of locking into fixed

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investments in a world of changing circumstances. These uncertainties have been compounded by the fragmentation of world markets resulting from import substitution behind tariff barriers and regional trading blocs. U.S. firms are investing abroad with greater caution: net capital outflows, for example, declined 27 percent in 1976 to $4.6 billion.

The growth of host country restrictions, regulations, and limitations on foreign investment has also tended to detract from this traditional mode of overseas involvement. Import restrictions are commonly imposed by countries that, like Brazil, suffer balance-of payments deficits due to increasing oil import bills. Even some of the oil-rich countries, such as Venezuela, keep a close eye on imports and costly foreign-exchange expenditures. Another inhibiting factor in this area is the limitation by law of employee layoffs. In some countries these laws are so strict that a U.S. corporation is forced to consider labor a fixed cost, regardless of prices or demand for the product. In addition to being legally obligated to make individual termination payments, some U.S. corporations must also develop, in collective bargaining with unions (and sometimes with the government), "social plans" which require additional cash indemnities to workers.

At the same time that certain changing circumstances in host environments have soured corporate attitudes toward direct investments in overseas plants, there is evidence that some U.S. firms are encountering difficulties in adjusting to technical change at home and in obtaining competitive production in the high-wage U.S. economy. Production in other countries of labor-intensive components of manufacturing for reexport back to the U.S. for final assembly has long been a practice of U.S. industry. Today, some of the more capital-intensive elements (such as entire engine plant facilities) are also allocated to foreign affiliates in order to maintain competitiveness in world markets. Certain firms are also retrenching from new investment commitments in basic research aimed at new product development in favor of more pragmatic, quick-payoff development of existing technology. Explanations for the reorientation in R and D by U.S. corporations include continued high rates of inflation, shortage of capital funds due to the stock market slump, fierce competition worldwide in high-technology industries, and uncertainty about U.S. government regulations and policies.

An increasingly interesting alternative to either overseas or domestic investment in production facilities and R and D has emerged in the sale of manufacturing know-how and related services, such as training of foreign nationals in technical and managerial aspects of operating industrial systems, or assistance in procurement, start-up, and international marketing.

Enhanced bargaining leverage of technology purchasers. The degree of autonomy U.S. corporations have traditionally enjoyed in making decisions as to the kinds of technology they released and the terms of transfer has been considerably diminished by a gradual increase in the bargaining leverage of technology purchasers. The enhanced bargaining leverage derives from a variety of new conditions which redound to the advantage of non-U.S. purchasers. Any one condition, in and of itself, is not necessarily determining; but combined, these new conditions result in a marked shift in the balance of bargaining leverage between technology suppliers and purchasers in favor of the latter.

This shift in bargaining leverage is perhaps most immediately attributable to the proliferation of alternative sources of similar, if not equally attractive, technology sought by a purchaser. The number of product and process fields in which the U.S. industry holds a monopoly position in know-how is rapidly declining. That enterprises in other industrially advanced countries have become alternative suppliers of first-class, operative technology is a result, in part, of an earlier proliferation of design and manufacturing capabilities by U.S. firms. The Japanese, for example, have become significant competitors with U.S. technology in the late 1950s and 1960s. The socialist countries might follow suit in time, depending on the volume of transfers and the efficiency of implantation.

Developing nations with oil and mineral resources have begun to use their newly derived wealth to acquire industrial facilities and know-how to process their raw materials for world markets. Most of these resource-rich countries have heretofore played marginal roles in the world economy. Their greatly enhanced earnings obtained from coordinated pricing and volume-of-production policies have given them considerable bargaining leverage in negotiating with multinational corporations. This kind of leverage has accrued not only for the oil-rich countries but also to a lesser extent for nations having bauxite, copper, and other raw materials. The ability to pay in hard currency for expensive technology, which eliminates complicated and long term financing arrangements, is being used as strong leverage in negotiations.

A final factor in the shift in bargaining leverage has been the perceptible upgrading in recent years of the knowledge and skills which technology purchasers bring to bear in negotiation sessions with multinational corporations. Trained in the best business and law schools in the world, negotiators for purchasing enterprises have become well versed in the laws concerning industrial property rights, patents, trademarks, and industrial know-how.

[The original study goes on to present 16 case studies of advanced technology sales in the aircraft, automotive, computer, consumer electronics, and chemical engineering industries. Two of these involving developing countries are summarized here.]

## Case Study 1: GTEI's Turnkey Plant in Algeria for the Manufacture of Consumer Electronics Products

Late in 1974, GTE International, Inc. (GTEI), a subsidiary of the General Telephone and Electronics Corporation (USA), signed a contract for the construction of a $232 million consumer electronics manufacturing plant with the Algerian enterprise SONELEC. SONELEC is the state corporation responsible for the development of an Algerian consumer electronics industry. The *produits en main* contract requires GTEI to develop a vertically integrated operation that is virtually self-sufficient in component parts manufacturing including semiconductors, final product assembly, and product design-engineering. (*Produits en main* contracts are similar to "turnkey" projects: the supplier provides training of all levels through top management, all the equipment, and aims to provide the purchaser with self-sustaining ability to operate with no outside help.)

The transaction is significant because of its size and its potential impact on the world consumer electronics industry. It is also illustrative of the scope of development goals Algeria has set for itself. Basically, SONELEC has purchased the capacity to become a significant factor in international consumer electronics: when the vertically integrated plant comes on-stream, SONELEC will have a significant export potential. It will have an independent technological base that will be supplemented by related know-how during the life of the contract, and allow the company to remain a state-of-the-art competitor. In addition, several hundred SONELEC employees are being trained in relevant technical areas so that the company will have a work force that can operate independently in the design and manufacturing areas. Finally, SONELEC will have a vertically integrated plant that will operate with limited dependence on foreign components, and will also provide existing Algerian companies in the same sector with a domestic source of previously imported component parts.

The GTEI plant is being built in Sidi-Bel Abbes and will employ 5400 people. Once completed, it is expected to have the following annual production capacity on a one-shift basis:

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|---|---|
| TV sets (black and white) | 190,000 |
| TV sets (color) | 50,000 |
| Radios (transistor) | 410,000 |
| Stereo/phono | 50,000 |
| Cassette players | 60,000 |
| UHF/VHF tuners | 250,000 |
| TV picture tubes (black and white) | 238,000 |

The Sidi-Bel Abbes facility will be Algeria's second major consumer-electronics manufacturing facility. A privately owned facility located at Blida has a production capacity of 200,000 TVs and 100,000 radios annually. The plant employs 1500, and it is heavily dependent on foreign components. Over 50 percent of the sophisticated parts at present are imported. It has been speculated that production at the Blida facility will wind down as the SONELEC operation comes onstream.

At the end of 1971, there were 160,000 TVs and 700,000 radios in use in Algeria according to one estimate. By 1974, it is believed that annual internal demand had reached 120,000 new TV units and 100,000 new radios per year. Thus, Algeria could meet its current needs in radios and have a slight shortfall in TVs. The new GTEI facility will be used to supplement the domestic shortfall in TVs and in consumer areas not previously served by the domestic industry, most notably tape and cassette recorders. In addition, it will supply most of the essential component parts for the factory and the other domestic plant near Blida. Much of the surplus production in finished products is probably intended for foreign markets.

Approximately $25 million of the contract price is earmarked for technical and managerial training in the U.S. Two hundred and sixty-five SONELEC employees will receive up to eighteen months classroom and on-the-job training in the U.S. and Europe. An additional 105 Algerian students will learn English and receive instructions in relevant technical undergraduate course work. SONELEC expects that this investment will provide the complementary manpower pool of executives and technical people it needs to maximize its gains from the capital investment in this new electronics facility. Training for this industry's specific application, instead of a generic educational program, has been dictated by necessity and represents a departure from recent procedure in Algeria. There has been a flaw in Algeria's state planning: it has limited its reliance on foreign technical and executive expertise at a time of expansion when it has had an inadequate domestic manpower pool. Consequently there have been operational difficulties, quality-control problems, and market development failures in different fields. At present, its industries are operating at 30 to 60 percent of capacity.

From GTEI's point of view, the SONELEC contract offered a host of advantages and entailed acceptable levels of commercial and economic risk. First, the terms of the contract call for the transfer of technologies limited to the design and engineering of a specific manufacturing facility, and production of specific products. The contract is executed over a finite period and tied to an existing state-of-the-art technology. Although the agreement requires GTEI to keep SONELEC informed about new technical developments, they will not necessarily be incorporated into the plant. Currently GTEI is making rapid advances in technologies relevant to the consumer electronics field, and is incorporating these into its product lines;

therefore, it will probably not suffer an erosion of its competitive position in world markets as a result of SONELEC production. In any case, the TV design provided by GTEI to SONELEC is not in compliance with U.S. standards. This safeguard eliminates the possibility of exports to the U.S. market without major product-design alterations.

For several years after the plant is on-strem, SONELEC will, under the terms of the contract, continue to be dependent on GTEI for some of the key ingredients needed in the component manufacturing and final assembly. Algeria is not a traditional export market for the U.S. electronics industry, and without this contract GTEI would have virtually no export potential in this market. GTEI was interested in winning this contract because it would serve as a sorely needed stimulant for its electronics division. The company, along with the rest of the U.S. industry, was faced with the prospect of idling installed capacity because of a dramatic drop in consumer demand and the increased competition from cheaper Japanese imports during the early 1970s. The contract assured continued plant utilization and retention of trained production workers for the company's operation in New England, and would provide business for numerous local subcontractors.

In short, there clearly were substantial benefits to be derived from the SONELEC contract. And had GTEI not consumated the agreement, there were several foreign competitors who would have, including Thorn, Ltd. (United Kingdom), Nippon Electric (Japan), and IT and T Standard Electric (Germany). By not entering into the agreement, GTEI and other U.S. firms would have lost follow-on business for the supply of GTEI component parts and contingent goods and services valued in eight figures per year over and above the basic contract. The company would also have forfeited future market opportunities in this sector of the Algerian economy: once the plant is in operation, the Algerian government will close the border to competing imports. And the probability that SONELEC will become a direct competitor in world markets anytime in the near future is slim. The Algerians feel the consumer product designs they are getting from GTEI will be good enough for the Algerian market from a functional standpoint for some time to come. If at some time in the future SONELEC found it worthwhile to export to markets where GTEI is active, technological upgrading would become indispensable.

### Case Study 2: The Piper Aircraft Corporation Licensing Agreement with Empresa Brasileira de Aeronautica, S.A.

In 1974, Brazil represented the largest single export market, outranking both Canada and Germany, for U.S. small aircraft manufacturers: they delivered 726 planes to Brazil in that year at a cost of $600 million. Severely pressed by this time with foreign-exchange constraints and confident of its technical capabilities and sufficient internal market demand, Brazilian authorities felt it was an appropriate moment for the state-owned aircraft enterprise, Embraer (Empresa Brasileira de Aeronautica, S.A.) to begin a manufacturing program of light aircraft, single- or twin-engine, in close cooperation with a foreign aircraft manufacturer. Embraer was created in the late 1960s for the purpose of promoting the development of the local aircraft industry. After six years of operation, it had three lines of aircraft in production: a single-engine crop duster designed by Embraer, and two military planes under foreign license. As of late 1974, Embraer employed 3500 people and had a total capitalization of about $20 million.

In 1974, Brazil sent a mission to the major U.S. small aircraft producers to solicit proposals on an agreement for production by Embraer in Brazil of U.S. planes. Embraer approached Piper, Beech, and Cessna, the last of which held more than 60 percent of the Brazilian market in 1974. According to Embraer, all three firms were fully apprised of the rules of the game; that is, the Brazilians made explicit their intent to develop their own technical, managerial, manufacturing, and marketing capabilities in small aircraft production and to reserve exclusively the domestic market thereafter for Brazilian-produced aircraft. The second goal, it was explained, was not so much an intent to create a protected industry but an effort to realize foreign-exchange savings. Implicit in these rules was the eventual outcome that only the foreign firm prepared to enter into an agreement with Embraer would be permitted continued participation in the large Brazilian market.

In the early phases of the negotiations, competition among the three U.S. firms was spirited, especially between Cessna and Piper. Initially, Embraer had a marginal preference for Cessna because it enjoyed wide recognition and confidence within the country and an effective distributorship system. Beech dropped out as a serious contender quite early, taking the position that if Brazil wanted its aircraft, it would have to import them from its U.S. facilities. From all appearances, Cessna initially entered negotiations in earnest with a preparedness to release technology and managerial control to Embraer for production of its aircraft. Its ultimate position, however, was not unlike Beech's. Evidence of Cessna's true intent was its adamant refusal to grant Embraer authority to make modifications it deemed appropriate in the Cessna aircraft models the company chose to manufacture. A second difference that arose in negotiations concerned royalty payments. Embraer wanted no royalty obligation for manufacturing know-how acquired from the foreign partner, and Cessna felt it was a legitimate term for the agreement.

Undoubtedly, several more subtle difference arose between Cessna and Embraer during the negotiations; the outcome was that Piper was selected. As was implied by Embraer officials prior to entering into negotiations, U.S. exports of small aircraft to Brazil have plummeted. Cessna, which in 1973 sold more than 400 aircraft in the Brazilian market, sold only 5 in 1976. This sales plunge is the result of a 50 percent tax (raised from 7 percent) imposed in 1975 on imported planes of this category, and the requirement of the Brazilian government that importers make a one-year interest-free deposit covering the full price of manufactured goods bought abroad. In addition, Brazil's law of similars stipulates that once an item is produced in "sufficient quality and quantity" in Brazil and registered with the government as a product similar to its imported counterpart, it will be protected from imports.

The industrial cooperation program with Piper is based on two agreements -- one for single-engine aircraft and one for twin-engine airplanes. Under the terms of the agreements, Embraer may select any Piper model it desires for local production. Thus far, the following models have been chosen: three models of Cherokee aircraft and the Lance, Seneca, and Chieftain. Piper is responsible for providing the necessary assembly and parts manufacturing know-how and assisting in such areas as quality control, materials handling, and manufacturing. Piper has an option to use its international distribution system for aircraft that may be exported from Brazil. The U.S. firm's compensation is primarily a percentage return on the components it ships to Embraer. As the licensee progressively substitutes local content for these imports, the returns will diminish. Even at 100 percent production in Brazil, however, Piper still will be paid a fee for service in support of those aircraft. With the exception of those items that cannot be economically produced in Brazil, local substitution is expected to proceed smoothly.

At the present time, the Piper program is basically a licensing agreement; but in the medium and long term it could provide for the cooperative development of new aircraft. The agreement specifically permits Embraer to fabricate Piper aircraft for sale in the domestic market and, on occasion, to produce jointly with the U.S. company for foreign market sales; to replace on a gradual scale Piper-supplied components with Embraer-fabricated products; to initiate joint programs to share development and production of a new aircraft aimed at domestic or foreign markets; and to market one another's products through individual distribution networks. Production capability for the Piper models is being transferred to Embraer in three phases. By Phase III, Piper will be shipping all component parts for assembly by Embraer, and in three subphases will: (1) begin replacement of Piper-supplied parts by Brazilian-made equivalents, including interiors and 50 percent of both fiberglass and acrylics; (2) complete replacement of all remaining fiberglass and acrylics and produce all harnesses; and (3) produce the aircraft completely with Brazilian-manufactured parts and components with the exception of those that cannot be economically produced in Brazil. Upon completion of Phase III-3, Embraer projects that from 66 percent to 70 percent of the Piper product will be of Brazilian origin (based on U.S. prices).

The development of the Brazilian aircraft industry has been shaped by three ten-year plans spanning the period from 1950 to 1980. A government-funded organization known as Centro Technio Aerospacial (CTA) has been given responsibility for directing this program. In the first ten-year period, CTA sought to establish a teaching and training program to develop a support structure for the aviation industry. The second period required the establishment of technically strong local manufacturers. The third period was characterized as one of increasing the sophistication of locally produced power plants, avoinics, and aircraft systems that will go into Embraer products. CTA has aided Embraer by helping it to modify its Bandeirante designs. The primary means employed to develop these supporting industries is a series of partnerships with foreign firms. An effort is made first to make each industry financially capable and then to upgrade its technical competence to aeronautical standards. To assist and accelerate the latter process, one foreign firm is normally selected for each industry. Brazil's specific areas of interest concerning foreign partnerships for developing its aeronautics industry include both reciprocating and turbine engines, avionics, hydraulics, instrumentation, and raw materials such as aluminum and steel. CTA has begun earnest discussions with a number of foreign firms in these fields.

Although the future of Brazil's aerospace industry looks promising, there are certain weaknesses that only experience and competition will overcome. Embraer is highly engineering-intensive and therefore will experience difficulty in keeping costs down. Regardless of how well engineered an aircraft is, unless it is price competitive in the international market, it will not be a successful seller. Price is especially important if Embraer expects to sell 50 percent of its EMB-12X line in the export market against such fierce competition as the Beech 100/200 and the Swearingen Merlin. Retail base prices of Embraer's Piper models average 27 percent above those charged by Piper in the U.S. Embraer-produced aircraft also suffer from low-quality interiors; the materials now being utilized will not hold up under hard use. Piper officials have indicated that they will do the completions in the U.S. should they choose to market the new pressurized aircraft through its domestic and worldwide distribution system. Another deficiency in Embraer is its lack of effective marketing tactics. Its program has been criticized by Brazilian dealers experienced in high-pressure international markets for being insufficiently aggressive.

While the rest of the South American market for light aircraft appears to be sewed up by assembly programs of Cessna and Piper in Argentina and in Colombia for the Andean Pact countries of Venezuela, Ecuador, Peru, Bolivia, and Chile, the African market is still quite accessible. Brazilian marketing efforts can be expected to aim first in that direction. If the Brazilians have aspirations of marketing their EMB-12X models in the U.S. market, they must first drop some of their own high trade barriers. The 123 and 120 could not possibly compete with Beech and Swearingen on an equal footing with a similar 50 percent import tax imposed on the airframes coming into the country.

Brazil is not unique among the more industrialized of the developing countries in its desire to develop an indigenous aircraft industry, but it may be unique in its professional approach to achieving that end. Its strategy of effectively closing entry to its markets for all but the foreign firm prepared to share front-end technology, to impart sophisticated design and engineering capabilities, and to instruct Brazilian nationals in managerial skills has been extremely successful. Foreign firms, facing narrowing opportunities to earn returns in foreign markets, have been extremely eager to meet these conditions. Brazil, a state capitalist economy, has the means to accumulate large sums of capital and therefore can exercise considerable leverage in negotiating with foreign firms. In time, the sustained enterprise-to-enterprise relationship that characterizes Brazil's effort to develop its aerospace industry will result in the implantation of internationally competitive design, engineering, and production capabilities. While the U.S. firms that have taken advantage of the opportunities offered by Brazil will benefit, other U.S. firms in the industry can expect increased competition in third-country markets from Brazilian aircraft in the future.

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Technology and the Multinationals,
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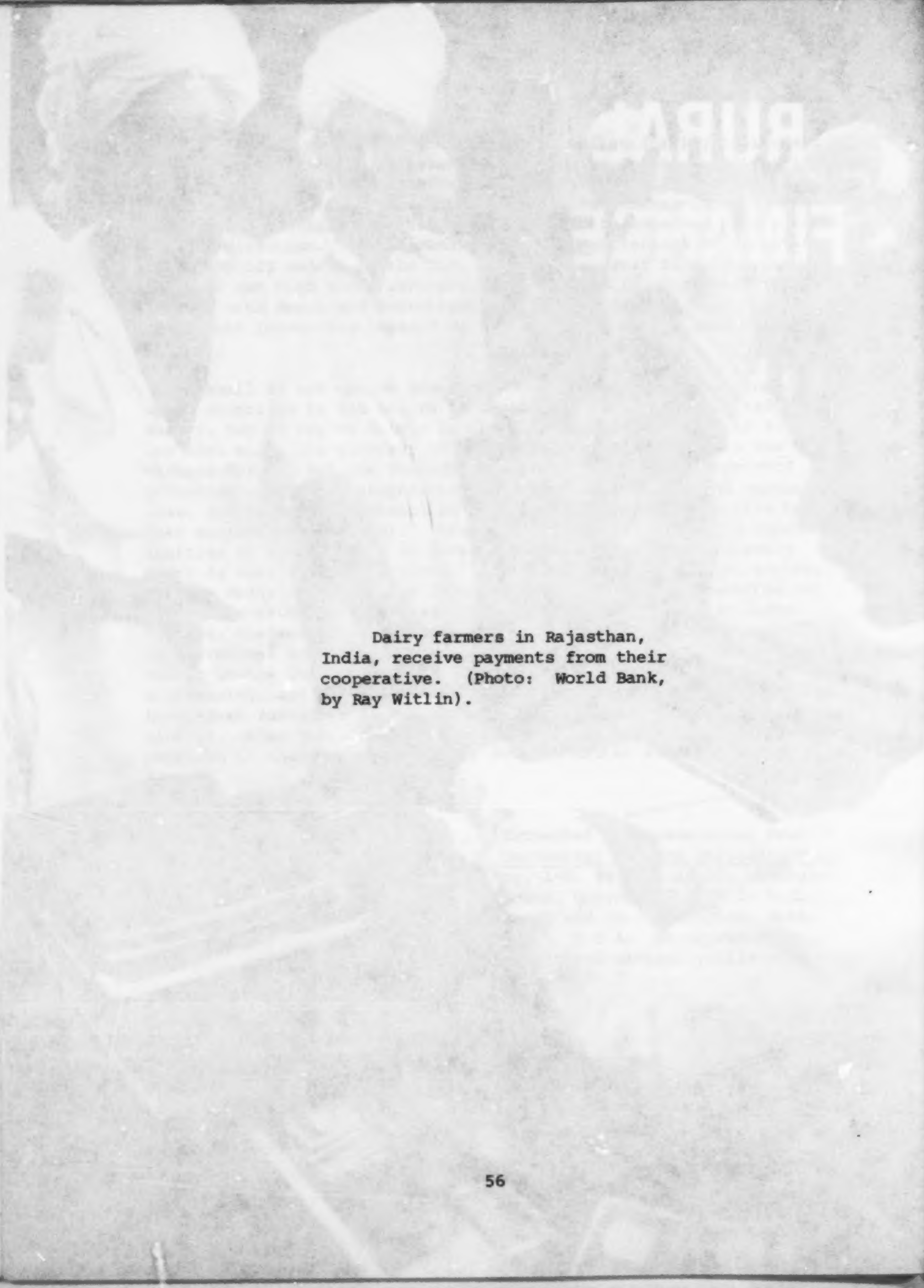
# RURAL FINANCE



Dairy farmers in Rajasthan, India, receive payments from their cooperative. (Photo: World Bank, by Ray Witlin).

# Invierno: An Innovative Rural Program in Nicaragua

Claudio Gonzalez-Vega and Ronald L. Tinnermeier

[A rural development program pioneered in Nicaragua emphasizes credit and agricultural inputs to which small farmers have access. A number of innovative methods, some involving computers, have succeeded in greatly reducing the costs of supplying these items to poor rural areas.]

The program adopted by the Institute for Campesino Development (INVIERNO) was part of a major attempt by the Government of Nicaragua to restructure the public institutions and policies serving the agricultural sector. In early 1972 a National Agricultural Committee was established to define a new strategy for rural-agricultural development. This resulted in a policy stragegy in 1975 intended to "improve the standard of living of the rural population through greater access to the flow of goods and services, and increased participation of the individual in the decisions that affect his progress." The Ministry of Agriculture was to be relieved of direct operating functions, and would become the leader and coordinator of activities in the rural sector. The Ministry's operating functions, in turn, were to be distributed among various autonomous institutions. One of these was INVIERNO, whose sole responsibility and orientation would be to stimulate the development of small farmers by making various required services more effective at the local level. INVIERNO became operational by the middle of 1975; field offices were officially opened in March 1976 and loan disbursements to small farmers began in April 1976. Administrative

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manuals governing the organization and its procedures as well as manuals for the credit, input delivery and marketing programs were prepared during the first six month period.

## INVIERNO Objectives

INVIERNO's primary objective "is to develop in the individual lower income rural farmer -- the campesino -- the capability and means which will enable him to have access, directly and jointly, or in coordination with other agencies, to the opportunities and services which he needs for his development with the purpose of promoting a sustained increase in his standard of living". The institution deals with the non-farming but rural poor as well, through development efforts of the newly formed community councils and through INVIERNO's small scale rural industry program.

To determine an individual's eligibility for the program, an upper income limit was at first set at the average national per capita income of US $590; this was converted into a farm size limit of 69 hectares. However, INVIERNO was criticized for setting such a high limit, with about 78 percent of the rural families owning less than 3.5 hectares of land or no land at all; it was thought that over time the benefits of the program would tend to accrue to those at the upper end of the scale if the maximum size were not lowered. In practice, however, INVIERNO started by serving farmers and landless laborers with sizes of farms and incomes well below these limits. One of the reasons for this has been the focusing of its efforts on farm communities with no more than 300 families, which usually are characterized by small farms. Regional concentration was also a factor: work was begun in two regions (of eight in the country) because of a large number of small and relatively poor farmers and communities in these areas. It is expected that INVIERNO will expand into the other regions when resources and financing permit, by which time costs should be reduced and lessons from experience incorporated.

The distribution of loans by size and region through September 1977 is shown in Table 1. More than 78 percent of the loans are for less than US $429 for the two regions serviced by INVIERNO. Very few loans are over $2,100, and these must go through a special review process by a senior level credit committee. The number of relatively large loans declined significantly during the second year of operation. The average size of loan also has declined slightly over time.

Table 1

Distribution of Loans by Size and Region Through September 1977

| Loan Amount (US $) | Region II Number | Region II % | Region V Number | Region V % | Total Number | Total % |
|---|---|---|---|---|---|---|
| Less than 143 | 175 | 18.2 | 2,538 | 36.2 | 2,713 | 43.0 |
| 144 - 428 | 546 | 56.8 | 3,015 | 43.0 | 3,561 | 44.7 |
| 429 - 714 | 160 | 16.6 | 783 | 11.2 | 943 | 11.8 |
| 715 - 1000 | 48 | 5.0 | 286 | 4.1 | 334 | 4.2 |
| 1001 - 1428 | 20 | 2.0 | 182 | 2.6 | 202 | 2.6 |
| 1429 and over | 13 | 1.4 | 202 | 2.9 | 215 | 2.7 |
| TOTAL | 962 | 100.0 | 7,006 | 100.0 | 7,968 | 100.0 |

Source: INVIERNO, ... Evaluacion.

The average size of the land area financed per loan by INVIERNO also has been very small, ranging from 1.9 to 3.3 hectares for each cropping season. As with loan size, the average size of farm of the borrowers decreased in the second year -- see Table 2. During 1976 almost half of all loans authorized were for farmers with less than 3.5 hectares of land; in 1977 this proportion increased to over 81 percent. For farmers with more than 7 hectares, the proportion of loans authorized declined from more than 30 percent to just over 7 percent. This substantial reduction in farm size resulted partly from the institution's efforts to eliminate a few large borrowers as it gained confidence in its objectives and procedures; the incorporation of Region II during 1977 also added a larger number of smaller farmers. Finally, drought problems in some areas resulted in farmers planting less, which reduced loan size and area financed per farmer.

Table 2

Percentages of Loans Authorized by Farm Size and Cropping Period

| Farm Size in Hectares | 1st Crop 1976 | 2nd Crop 1976 | 1st Crop 1977 | 2nd Crop 1977 |
|---|---|---|---|---|
| Less than 3.5 | 45.0 | 49.0 | 83.2 | 81.1 |
| 3.5 - 6.9 | 22.0 | 22.0 | 10.3 | 11.4 |
| 7.0 - 13.9 | 15.0 | 14.0 | 4.8 | 5.4 |
| 14.0 or more | 18.0 | 15.0 | 1.7 | 2.1 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 |

Source: INVIERNO: Informe...1975-1976, and Informe...1977.

Corn and beans are the major crops financed under the program. Test plots have been established to allow the financing of other crops, especially vegetables, as technical recommendations are perfected. In addition, credit was made available to rural but non-farm residents in 1977 as part of INVIERNO's comprehensive approach to rural development. In that year a total of 292 loans for $369,557, or an average of $1,265 per loan, were made to small businesses, small scale industries, service firms, and artisan works.

### Innovative Approaches

Integrated services. The primary objective of INVIERNO is to improve the level of living of the low-income rural resident. INVIERNO is attempting to provide its beneficiaries with a set of integrated services. These activities include institution building, agricultural credit, technical assistance, marketing help, community action (called MOC -- to Motivate, Organize, and Capacitate), municipal development, small farm adaptive research, land sale guarantees, cooperative development, access road construction and improvement, small rural and artisan enterprises, and rural housing. Rather than take on all these activities directly and at once, INVEIRNO decided to handle certain services itself and to coordinate selected services with other institutions and agencies. At present, INVIERNO is providing agricultural credit, technical assistance, marketing assistance, and community action to its beneficiaries. Through support services by other public agencies, INVIERNO has promoted access road construction, infrastructure and municipal development, and research oriented to the development of technology appropriate for small farmers. Also, education, health services, and electrical power are provided under the Institute's coordination.

This strategy of integrating services is consistent with an observation resulting from the U.S. Agency for International Development (AID) 1973 review of its credit programs that: "Credit institutions working within an integrated program have a better overall success". At the same time, this strategy increases the demands on the institution's financial, administrative, and managerial resources and capabilities and may, in turn, reduce the numbers of clientele that can be reached in a given period of time.

In practice, the extent to which the various services have been provided by INVIERNO has varied. Credit has been given first priority, while most of the other services have been organized around and for the sake of the credit operations. This has not happened by planning or conceptual design. Rather, it reflects INVIERNO's attempts to get things moving, given its institutional constraints and political circumstances. Credit was a particularly difficult component, but it was the activity which most significantly influenced the institution's image with the Government and with the public. However, there is danger that only borrowers will benefit from the program, and not other non-borrowing rural residents. INVIERNO is aware of this danger and is attempting to correct it by focusing on community action, and by incorporating the communities into the formulation of its operating plans. Some problems in integrating services at the local level have arisen due to the difficulty of coordinating operations with other public agencies. This was particularly true with marketing. Initially, INVIERNO signed a contract with another government agency for the marketing of basic grains produced by the small farmers, but the farmers chose not to market through the public agency, dealing instead with private intermediaries. As a result, INVIERNO was forced to look for other ways to assist the marketing of small farmer crops. It is now limiting its marketing aid to the dissemination of information about crop prices, hiring trucks for transport, and establishing contacts between buyers and sellers. In the future INVIERNO expects to promote on-farm storage to allow farmers to sell their crops at a time when prices are more favorable.

INVIERNO's general philosophy is to deal with the total needs of the rural resident at his doorstep or at least in his immediate area. Its intent is to assure that the services which may be necessary for an improvement in the level of living of the rural population will arrive at a time, and in a form, quantity and place, which can facilitate the rural residents' own self-help efforts. All of this is accomplished through multi-disciplinary mobile teams at local Development Centers (CEDE), usually located in market towns. This team normally is composed of an agricultural technician-extension agent (AGROMOC), an input and marketing specialist (CREDOMERC), and a community specialist.

INVIERNO's strategy has been to saturate any geographic area to be served by a CEDE in order to minimize operating costs. This gave special importance to the selection of the new localities to be served. An eligible locality must be situated within a 25 kilometer radius from a CEDE or SUB-CEDE (branch office), must have an all-weather access road (if not, building it will have high priority in INVIERNO's planning), must have agricultural potential, and must include at least 20 houses within a 5 kilometer radius. These criteria were selected so they could provide services at the lowest operational cost possible.

Program Management. A consensus has been emerging among development specialists to the effect that management is a critical factor in the success of any agricultural credit or integrated rural development program, especially in the delivery of services to the poor. This management is not "a thing apart", but becomes closely intertwined with technical activities: it includes the implementation of a system for planning, methods of supervision, use of a systems approach in judging the resources required for service to the rural poor, the elaboration of operations manuals in order to introduce discipline into the various practices, and the training and assistance in realistic methods for organizing the poor. All this has been particularly important in the case of INVIERNO, as it is a large and complex program for the delivery of an integrated package of services to small farmers. Achievement of the institution's goals has placed very heavy demands on an efficient management system, and the quality of this system has been a key element in the relative success of the institution.

The main factor in managerial success has been the competence of INVIERNO's staff. Although pleased with the results of their efforts and with the appreciation by various observers, INVIERNO's managers and professionals have continued with their practices of rigorous internal evaluations, their search for better approaches and methods, and their desire to anticipate potential problems due to the expansion of their operations. One of INVIERNO's salient features has been the desire that its personnel be of the highest quality, both in education and competence. To assure this, INVIERNO has implemented a highly professional personnel system which combines a competitive salary scale, a liberal fringe benefit package, and an effective system for the selection and promotion of the personnel from within, which includes six-month individual employee performance evaluations. All INVIERNO positions are given job descriptions with their responsibilities and authorities defined, along with the minimum qualifications required of an incumbent. The attractive pay and this classification system has helped bring persons to INVIERNO with substantial academic training and prior work experience, in many cases much exceeding the minimum requirements. In turn, these high quality people have tended to stay at INVIERNO in view of the professional stimulation provided by the institution as well as its dynamism and innovative approaches. A high degree of professionalism is particularly evident throughout the institution. This is highly significant, given the continual problem for public institutions in low-income countries of keeping good people.

Planning has been given high priority throughout the institution, and a great deal of effort has been devoted towards achieving a clear definition of INVIERNO's philosophy, objectives and approaches. This planning function takes place at all levels of INVIERNO, primarily through planning meetings and planning records, as well as through a once-a-year overall planning exercise with community participation. Department and Division heads keep track of project objectives and individual program objectives through the use of individual standardized planning sheets. Each department sends in a narrative description each month to the Department of

Programming and Control. There has been an increasing use of PERT charting. Similar planning records are maintained at the Regional Office and CEDE levels.

Along with the planning and progress records, the key to planning has rested on a series of closely synchronized meetings at the Central Office, Regional Office and CEDE levels. Every other Monday the Central Executive Committee meets in Managua, both as a decision-making group and a planning body where short and long term strategies are discussed and agreed upon. This committee consists of INVIERNO's General Manager, two Vice-managers, Department and Program Directors, and all the Regional and CEDE Managers. In turn, the regional staff meets with the Regional Manager to learn about results of the Managua meeting and to provide the information resulting from the periodic meetings at each local CEDE. These synchronized meetings have been good devices, both for management and for a flow of information for planning and operations from the top down and the bottom up. INVIERNO is also critically aware of the importance of evaluation. Therefore, several elements have been introduced that will permit internal and external evaluations. In the institution's overall plan certain quantifiable goals have been established which have become benchmarks against which actual results can be measured.

Loan procedures. INVIERNO's agricultural credit component has been designed to address the problem of making credit available in small amounts to a fairly large number of small farmers, at reasonable costs, and adjusted to meet their needs. In this connection, INVIERNO has adopted several innovative concepts and procedures which, if successfully implemented, would be particularly relevant for other small farmer credit programs in developing countries.

The identification of potential beneficiaries is achieved through a "census" performed by the AGROMOCs in each one of the localities served. In effect, each locality is canvassed completely to explain the credit program and to ascertain the needs and desires of the residents for credit. This first step is a reflection of INVIERNO's philosophy of bringing the public sector services to the locality of every potential beneficiary. If during the census, a resident wishes to get a loan from INVIERNO, a two-page census form and a loan application appropriate for electronic processing are filled out, reflecting the interaction between the farmer and the AGROMOC. All of this basic information is later used in the computerized evaluation of the loan application; weights are accorded different borrower characteristics found by INVIERNO (or estimated) to be important. If the loan is approved, the amount of the loan is calculated and a loan contract, notification letter and enterprise budget are printed -- all electronically -- showing the dates of anticipated withdrawals of funds and the amounts to be financed for specified inputs.

This procedure has significantly reduced INVIERNO's administrative costs per loan. It has released CEDE-level personnel for activities other than loan processing, and it has eliminated many of the errors resulting from hand processing. Moreover, since all loan applications arrive at about the same time at the beginning of the planting season, INVIERNO would require a large number of trained staff to adequately process the applications within a reasonable period of time so that loans can be used for inputs when they are needed. Nevertheless, borrowers still complain about the excessive delays in loan approval and fund disbursement, even with computer use. A trend towards group lending has emerged as a means of further reducing costs and delays.

Presently, approximately two weeks after the loan forms have been sent to Managua, each CEDE receives computer lists of approved borrowers with loan and input amounts. Summary lists of credit and input needs by CEDE and region are easily prepared to assist in coordinating input purchases and delivery logistics, since INVIERNO delivers the cash to the farmer in each locality and at the same time it provides inputs which the farmers can buy if they so desire. Initially INVIERNO had little idea about what factors and weights were most appropriate for borrower selection. During the first planting season a set of fairly restrictive criteria for acceptance were programmed. These criteria are being modified as more lending experience is gained and analyzed.

A second INVIERNO innovation in small farm lending was the introduction of a line of credit. The plan was to establish a five-year line of credit, the amount depending upon the acreage controlled by the farmer and his needs. Fund disbursement would be made in subsequent planting seasons. This line of credit contributes to a reduction of a farmer's uncertainty about the performance characteristics of the credit program. It also helps to reduce administrative and other transaction costs, both for the borrower and INVIERNO, since the legal and other expenses associated with yearly applications and loan contracts are avoided. Further, the institution can maintain a single account for each borrower rather than keeping one account for each loan operation into which the borrower enters, as is done in many credit institutions. INVIERNO has had some legal and other problems in implementing lines of credit, however, so this technique is not yet widely used.

When INVIERNO provides all of its services locally, this certainly increases the institution's costs; but it does not necessarily increase the social costs associated with the provision of those services. It has been found that the costs to small farmers of obtaining credit from public agencies are usually very high. Non-interest costs can represent 12 to as much as 74 percent of the amount of the loan, according to studies in Bangladesh and Brazil by Nehman and Adams. The sum of all of these individual costs of borrowing is very likely to be greater than INVIERNO's costs of reaching the borrowers, given the economies of scale and other administrative efficiencies achieved by the institution. Therefore, from a social point of view INVIERNO's strategy can be justified. In addition, if a significant reduction in administrative costs can be achieved through massive lending, then the strategy may become justified as financilly profitable to INVIERNO as well. The institution has been attempting to be self-sufficient in its banking program, and eventually expects to cover most of these costs with loan interest charges.

In summary, INVIERNO has established a loan application and credit-input delivery system designed to provide timely credit with associated off-farm inputs as cheaply as possible. Even so, problems have been encountered in making sure the inputs are actually available locally when the mobile team visits the locality to deliver the money. Multiple repeat visits to accomplish what could be done in one visit greatly increase delivery costs. INVIERNO is looking at ways of either improving the present system or finding other ways of delivering the credit and inputs.

Repayment by ability. Most credit specialists recognize a theoretical need to adjust loan repayment according to the repayment capacity of the farmer; but in practice this is not easy to put into operation. INVIERNO began experimenting with mechanisms which reflect the variability of agriculture, and thus, the small farmer's ability to repay a loan. Initially, INVIERNO estimated the farmer's repayment ability using a concept of income availability. An estimate of income available was based on estimated average yields and prices received in each area for the loan period in question, less an estimated amount for family maintenance. If available income were less than the estimated loan repayment obligation, the borrower would only be required to pay what it was estimated he could afford at that moment, and the balance due would be automatically carried forward. On the other hand, if income availability had been greater than the estimated loan repayment obligation, the borrower would have to pay the full estimated loan obligation plus 30 percent of the difference between what was available and what was due. This over-payment would be placed in an interest-bearing savings account in the client's name, to be withdrawn as he wishes.

This original concept of variable repayment would have been one of INVIERNO's most interesting innovations, because it helps protect both the farmer and INVIERNO against the risks and undertainty inherent in agriculture. Unfortunately, this concept turned out to be too ambitious and complicated for INVIERNO to handle in its formative years. Therefore, the system was never implemented. In its place, a "minimum payment" due under normal conditions of production is calculated for each borrower and reported every three months. The borrower is expected to pay this amount within six months of the report; if not, he is considered to be under willful delinquency. However, if the borrowers have suffered considerable losses due to causes outside their control, the "minimum payment" is adjusted accordingly and the loan is restructured. The adjustment is automatic for individuals if an entire area is affected, or is made piecemeal on an individual basis for isolated problems. Presently, however, there is no operational mechanism for inducing a more rapid repayment during good years, as previously conceptualized.

It is too early to evaluate the final efficacy of the present loan collection methods. The danger persists that the delicate concept of variable repayment, although highly desirable, may be misunderstood by field personnel and farmers alike, or not be correctly implemented, leading the institution over time into financial difficulties. In fact, at the end of October, 1977, over 29 percent of the borrowers were late in their payments, which represented about 15 percent of the total amount outstanding. This illustrates the importance of analyzing the causes for delinquency if a variable loan payment system is to survive where the credit component is expected to be self-supporting. It is hoped that using "community boards" to help select borrowers and to assist in loan repayment will improve this record. INVIERNO also is considering rewarding a community with a donation for a visible community project when it achieves a certain repayment standard.

Integrated technical package. The lack of profitable investment opportunities for small farmers has been one of the most serious problems facing the majority of agricultural credit programs in developing countries. Even when profitable investments are available, the additional risk associated with the adoption of unfamiliar technologies often has been more than the small farmer is willing to accept. Such deficiencies can bring about major difficulties for a credit program reflected in high delinquency levels, followed by restructuring of loans, and the exclusion of a major portion of the target group from receiving additional credit over time.

INVIERNO has placed considerable emphasis on raising small farmer incomes through the adoption of new technology, and it has experimented with a number of ways of reaching this objective. The key person for developing and introducing new technology has been the AGROMOC, the primary and continuing link with the farmer. The technical recommendations of the AGROMOC are based on three data sources:

(i) experimental work previously carried out by the Ministry of Agriculture and now by the Nicaraguan Institute of Agricultural Technology (INTA);

(ii) results obtained from field test plots run by the AGROMOCs and from the demonstration-training plots operated by selected farmers; and

(iii) the experiences of the farmers themselves in their own plots.

The technical knowledge resulting from these three sources guides the AGROMOC's recommendations to the farmers. The AGROMOC uses the test and demonstration plots in his technical assistance activities by directly involving some of the farmers in operating the plots, through periodic field days to demonstrate methods and results, and through individual contacts and group meetings to discuss new agricultural innovations, recommendations and experiences. The voluntary collaborators, chosen among members of a locality with leadership potential when INVIERNO starts operation there, seem to have been used primarily as messengers to alert the community to meetings, field days, etc. These voluntary collaborating farmers, however, could also be trained to serve as an element in extending technical knowledge and assistance to neighboring farmers, a considerably less costly delivery mechanism if it could be initiated and made successful. A study of data from AGROMOC daily time-use reports showed that up to 56 percent of their time on extension activities has been associated with individual farm visits. This has resulted in high administrative costs, as well as a limitation on the number of farmers being reached both of which are in direct conflict with program goals. As a consequence, INVIERNO is attempting to revert back to working with groups to correct this bias.

In 1977 there were two technological packages for farmers producing small grains. Package "A" was for the farmer with little or no prior experience in the use of credit for purchasing modern inputs. In this case the credit can be used to purchase improved seed, land rental, and to buy oxen, also for family maintenance. Major emphasis is placed on improved seed and weeding, water retention practices, and greater plant density. Package "B" is for the more experienced farmer; credit may be used for the items cited and also to finance hired labor, fertilizer, insecticides and other off-farm inputs. Soil samples are taken to guide fertilizer recommendations.

Typical crop budgets for these two alternatives for each of the major crops are prepared by the computer in the Central Office using the three previously mentioned sources of data. The limited number of technological packages is an obvious weakness in the program, given the significant differences usually found among zones and farmers. Furthermore, the centralized system seems to have the disadvantage of building rigidity into the selection of the packages. At the same time, however, it greatly frees the AGROMOC and other field staff from the time-consuming tasks of filling out crop budgets by hand, as is done in most other small farm credit programs. In any case much of the same rigidity has been observed in most of the non-computerized locally operated systems where, due to time and other constraints, a "typical" crop or farm budget ends up being used as the basis for most loans.

The computerized system has two potential advantages: (1) A much wider range of technological packages could eventually be made available to the AGROMOC and farmers; and (2) if data on actual loan uses by item are fed back into the system, it would be possible to modify the budgets so that they could come very close to what the farmers actually do. In addition, once reliable census or sample data on farm yields are obtained, an analysis of yield and net income by technological package used would provide valuable insights as to the most appropriate technologies to recommend for raising small farmer incomes.

INVIERNO contemplates developing other packages of inputs and farm management practices which will be an improvement over present practices. This includes looking for ways to utilize the farm family's labor and other resources more effectively to raise income levels. Some delay was experienced in initiating research directly applicable to INVIERNO beneficiaries (contracted with another government agency); unless usable research results are forthcoming, this could be one of the weakest links in the integrated program. The institution is just beginning to evaluate the impact of its programs at the farm level. Farm record keeping case studies are being carried out in the two regions; periodic sample surveys and other data collection techniques are being utilized to complement the case studies. Soon, considerable information should be available on levels of technology adoption, changing cropping patterns, attitudes, and income levels, as well as other economic and social data.

Computerization. INVIERNO has made an intensive use of electronic data processing for its operations and management. In addition to using the computer to handle conventional administrative activities like cash flow analysis, payroll and budgets, INVIERNO also is attempting some highly innovative work in applying computer technology to programmatic areas. The separation of banking and nonbanking costs, for example, is an outstanding example of an effort to clearly define and measure the costs of the various programs implemented by the institution. Another use of the computer has been made in the area of recording the use of time by field workers. By categorizing the time each outreach worker spends, INVIERNO has been able to evaluate the working patterns and efficiency of its field personnel. Another source of important information which the computer handles cheaply has been the computerized analysis of the results of demonstration and test plots.

INVIERNO's most important and innovative use of the computer has been its ability to process a large number of individual small loans at a relatively reduced cost. One of the most important factors which has militated against extending credit to small farmers in most countries has been the high cost involved in processing their loan applications. With the use of the computer INVIERNO is attempting to make this loan processing cost-effective. At the same time it hopes to produce timely decisions with respect to loan authorizations: a computerized decision-making model enables the institution to handle and make judgement about a large volume of small loans in a short period of time. In addition, INVIERNO acquires an effective control over the transactions involved, guaranteeing the quality of the services offered to the beneficiaries and the financial viability of the institution. Finally, the nature of INVIERNO's operations make indispensable a continuous follow-up, evaluation and reprogramming, with the aim of making adjustments on the basis of field experience. The computer significantly facilitates all these procedures.

The use of the computer, however, may not be free of dangers and other disadvantages. One important area of potential problems is the coordination of the data processing activities at the Central Office with the needs and requirements of the AGROMOCs and other field staff. Problems may arise as a result of delays, insufficient understanding of the computerized procedures or of the resulting outputs, and outputs in a form not readily usable by the field staff in their daily activities. The computer could become an important bottleneck during certain peak periods, particularly just before loan disbursement. As reported, there have been important delays in the notification of the loan authorizations and in the disbursement of the loans, but these have been due more to problems of data collection in the field or coordination of field activities than to difficulties in the centralized computerized operations.

In the second place, although the computer greatly reduces the administrative burden at the local offices, it also increases the problems of communication between the field staff and the Central Office, and particularly between INVIERNO's personnel and the beneficiaries. There is also a danger that the computer may be viewed as a problem-solver, and that administrators may develop too much of a dependence on the system rather than on their own agile problem solving. But the computer and related systems cannot solve new or unpredicted problems. Once the institution's management reacts to a new problem, however, it can process the information required for its solution with the use of the computer; and it can undertake computerized simulation and sensitivity analyses of alternative solutions in order to help choose the best one. A final limitation for adopting computerization in other countries relates to data transmittal. Nicaragua is a relatively small country with good road, telephone, and radio communication. Other countries may encounter overwhelming problems in transferring data for processing from field offices to the central office and back again within a reasonable time and with minimal error.

## Conclusion

There can be no doubt that INVIERNO is an extremely innovative effort to solve the problems of the Nicaraguan small farmer, and that it has made extraordinary progress in outreach during its first few years of experience. The particular innovations that have been tried are described above, and further experiments will doubtless continue. Its main strength has been the quality of its management system and the competence of its professional staff. One is favorably impressed not only by the novel concepts introduced and by the sophistication of the procedures employed, but particularly by the rigorous internal evaluation efforts, the continuous search for better approaches and methods, and the ingenuity and energy with which new problems are solved.

[Extracted from a paper presented at the Second International Conference on Rural Finance Research Issues, August 29-September 1, 1979, in Calgary, Alberta, Canada.]

Comment -- The statistics on which this paper were based preceded the fall of the Somoza government. Operation of all aspects of the economy in Nicaragua was, of course, disrupted by the Civil War in 1978-79. It is worth noting that the new government has approved the INVIERNO program, and wishes to pursue it even more vigorously than before. The program has been renamed "Pro Campo", and many of the people working in it have changed, but its methods have not. Current plans are to extend it to all parts of the country. Ultimate results of this effort will depend on the outcome of some undecided questions, notably those affecting the evolution of the land reform.

# Aspects of Money Lending In Northern Sudan

Martin W. Wilmington

[Village merchants and landowners, and persons with no other occupation, are found lending money to small farmers all over the developing world. Their interest rates tend to be very high, and they are often denounced by intellectuals and city dwellers. But their costs and risks are also high, and their services are adapted to client needs. This article gives the moneylender's side of the picture.]

Samuel Johnson once described the popular concept of the creditor as a man of evil appearance and intent, always eager to squeeze the last ounce of life out of the jovial, good-natured, charitable, and innocent borrower. While we hear much about the alleged profits and proclivities of the moneylender, we know little about his problems or the nature of the role he plays in society. Yet without an attempt to appreciate more fully his side of the story, it will be difficult to approach realistically the need for credit reform. It is frequently overlooked, for example, that many personal loans in Asia or Africa are made not for productive purposes but for such ostentations as lavish wedding feasts and dowries, on which no formal credit institution would extend credit to low-income borrowers but which nevertheless answer an urgent psychological need. No thought is given to the lack of debtor ethics which makes collection a strenuous and costly affair. Nothing is said about "bad debts" and the annual losses they cause the moneylender in countries where most borrowers are only inches removed from absolute destitution; high residential mobility -- particularly between

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city and country -- produces a high incidence of debt evasion; and low life expectancy coupled with the general absence of insurance makes every medium and long-term debt a special hazard. No consideration is given as to where the moneylenders themselves obtain funds for business: they, in turn, may have borrowed at the exorbitant rates from a tight capital market, or abstracted funds from profitable pursuits in other lines.

The impression is often conveyed that moneylenders get enormously wealthy from profits extracted from the poor. Yet the apparparent wealth of such lenders may come from occupations other than lending, which is often a subsidiary business of a merchant or landowner. Moreover, a great many moneylenders, despite the exorbitant rates of interest reported, do not seem to lead the prosperous life one might expect. Finally, an answer must be given to a phenomenon which has puzzled many reform-minded observers: Why does it happen so frequently that private moneylenders enjoy the continued patronage of poor rural and city workmen, even after socially oriented credit facilities managed by cooperatives or the state have been made available to them?

Bearing in mind the need for a more balanced study of the economics of the moneylending profession, I made a preliminary investigation of the problem during a stay in the Sudan. The information presented applies to the Northern Sudan, populated by Arab-speaking groups of predominantly Islamic faith; it may have some validity for the Middle East as a whole. To get the moneylender's side of the story is no easy matter. Most of the time he keeps no detailed records and has only the vaguest notion of the relationship between revenue, costs, and yields. His own calculations are based on hunches and rules of thumb rather than conversion tables. If he does have the facts and know-how to answer a Western-style questionnaire, he is too suspicious and secretive to bare his breast. My principal source of guidance, therefore, was government officials known to be familiar with rural problems of the country. One of them had the additional advantage of having been reared in the house of a moneylender and thus having observed the family business at close range.

Pattern of borrowing. Rural credit in the Northern Sudan is by and large in the hands of merchants and, to a smaller extent, landowners. In contrast to India and Pakistan, there are few people in the Sudan who make moneylending to cultivators their exclusive or principal business. Major banks like Barclays, the Ottoman Bank, the Arab Bank, and Credit Lyonnais have branches in the Sudan but steer clear of the small farmer.

Generally, credit is extended by the merchant-lender in the form of advances in money or kind against the next crop, an ancient system called *shayl*. Several types of *shayl* are practiced. The oldest form is an advance of grain or seed valued at a price substantially above the estimated price at the next harvest. The borrower must settle the loan by returning at harvest time enough grain to make up the money equivalent of the loan. If a good crop follows a bad crop, with a resulting drop in market prices, the lender may get back as much as five to six times the volume of goods he loaned out. Another type of arrangement under *shayl* is more in the nature of a middleman's service. Cultivators may find it difficult to market their crops for lack of funds to purchase sacks and meet transportation costs. The merchant will agree to take over the crop at the market price less an amount approximating the rate of short-term advances on crops. Still another form of *shayl*, which will serve as an example here, involves the advance of money against future crops. At the beginning of the season the cultivator will solicit a sum of money (or sometimes consumer goods) to be repaid in a specified quantity of produce, say an *ardeb* (5.6 bushels) of beans. The lender will set the amount to be lent against the future delivery substantially below the last harvest price or the anticipated value at the forthcoming harvest, whichever is lower. Thus, when the borrower surrenders the pledged quantity of beans, endowed with the higher valuation of the market, the lender, if his "hunch" was correct, should derive a considerable profit from the operation, namely the difference between the harvest value of the commodity pledged and the *shayl* value set by him.

How high is the rate of interest the lender expects? The amount varies, of course, from year to year depending on price fluctuations. Probably the best indication of what the lender expects to receive as "interest" comes from government data collected when grain prices were relatively stable thanks to government controls, so that the lender could foresee with greater assurance what the next harvest price would be. A typical transaction (reported by Daud Abdul Latif) was as follows:

| | | |
|---|---|---|
| Value of *ardeb* of beans, end of season...Egyptian | | P.T. 360 |
| *Shayl* value of beans, start of season.... | - | P.T. 200 |
| Gross profit of lender ............. | | P.T. 160 |

In other words, at the start of the crop year the borrower received 200 P.T. on loan. About ten months later, at harvest time, he was required either to surrender an *ardeb* of newly harvested beans or pay the current market price therefor. Owing to government controls, the lender probably knew that the harvest price would be 360 P.T.; the borrower therefore was expected to pay

160 P.T. for a ten-month loan of 200 P.T. Converted on a per annum basis, this would mean a rate of interest of approximately 100 percent.

## The Moneylender's Problems

What arguments could the moneylender present if called upon -- and willing -- to justify this high rate of interest? The case cited above involved a village merchant engaged in money-lending as a subsidiary business. In such instances the compensation derived from the use of capital for loans to cultivators -- rather than retail trading -- must be in some relation to the yield of capital investment in retail trading. Profit rates from wholesale and retail trade in the Sudan are relatively high: markups may be as much as 50 percent or over. What is more, the turnover of capital in trading is rapid; a merchant may roll over his capital as many as five times during one year. If he immobilizes a certain amount of his capital, say 100 piasters, by lending it out to a cultivator for a year, he may forgo the opportunity to earn a substantial return on several times the amount of the loan, say 500 piasters. The rate of interest on the loan, therefore, will reflect the alternative profit in trading thus sacrificed. This will be true even though he may be lending out idle capital, for the year-long immobilization of idle funds may deprive the lender of trading opportunities that turn up in two or three months. On the other hand, social pressures, as described below, and the desire to maintain a large market for his trading business will induce him to use some of his capital for loans to his cultivator-customers despite the beckoning of other trading ventures.

Secondly, protection must be provided against a miscalculation of market conditions at the next harvest. If, because of a bumper crop, the price of beans should drop below the *shayl* price, the quantity delivered by the borrower in repayment of his debt will be worth less than the amount of the loan. The discount must therefore be adequate to cover the wide price range within which agricultural commodities tend to fluctuate, and provide a cushion against losses from unforeseen price recessions in past as well as future years. So also a crop failure, although it drives up commodity prices, may be detrimental to the moneylender, for the cultivator may not reap enough to spare an *ardeb* of produce for loan repayment. He needs, after all, a minimum of grain for food and sowing; and the lender would incur communal ostracism if he tried to press his claim at the price of starvation or dispossession of his client. If there is a succession of bad crops, the lender's claim may remain uncollected for several years.

Often the condition of the cultivator after a bad harvest may be such that he has to borrow still more in order to feed family and flock and continue cultivation. The lender then will have to increase his investment in an already delinquent client if he wants to salvage his stake at all. To offset the loss, the *shayl* fee is compounded upon renewal or increase of the outstanding loans to double and triple the original rate. A vicious circle starts, and soon lifts the debt to astronomical levels. The borrower now may find himself enmeshed in a lifelong pattern of annual produce deliveries to the lender, only to be terminated by his death or unusual market conditions. (During World War II a record demand for Sudanese grain freed many cultivators from debt burdens endured for decades.) This "life-long servitude" of the rural debtor demonstrates two facts: (1) that the collection of debts in full after the lapse of contractual terms is no easy matter; and (2) that the high contractual rates of interest decried in many studies of moneylending are often not collected in full.

The Sudanese cultivator, for his part, often does not enter into debt with the notion that debt is something distateful and a moral obligation to be discharged as soon as possible. He may not save, or plan for a more modest wedding or dowry, because of a debt load. On the contrary, he may exert much resourcefulness to devise alibis for avoiding payment, and find means of withholding or concealing his crop from the grasp of the lender -- like his counterpart in some other parts of the world. Moreover, many cultivators manage to extricate themselves from their debt by joining the thousands of their countrymen who have found employment in Egypt. Once away on his northern trek, the debtor can seldom be traced; he will soon be swallowed in the vast crowds of Cairo, where he starts a new existence with a new occupation and a new wife. Debt evasion, therefore, is a risk of special magnitude to be calculated in setting the *shayl* rate.

Much has been said about the lack of effectiveness of laws designed to protect the debtor. There are, of course, courts in the Sudan to enforce laws against usury, but the debtor knows that once he appeals to the tribunal he may never get a loan again in his community. The lenders are a tightly-knit guild; they not only abstain from competing against each other by the offer of lower interest rates, but promptly join in the boycott of any cultivator who seeks his day in court. But the lender also finds little solace in the courts, although the law affords him certain rights. He is reluctant to go to court lest he awaken the borrowers to the existence of legal recourse. He knows that he can recover in court only a small part of the claim which he considers justified, since the law limits the rate of interest. As in other parts of the Middle East, land and property titles are often too confused to offer a reasonable prospect of success to foreclosure proceedings. Moreover, the lender may himself run the danger of a communal boycott of his other business if he does go through with foreclosure of a poor cultivator's land.

### Services Offered by the Moneylender

Not all the interest collected by the creditor is profit and risk insurance. Certain expenses and outlays have to be recovered, certain services rendered to the borrower must be compensated. Often the lender pays out of his own pocket the taxes and local imposts due on the crop delivered by the borrower. Often he must supply sacks and transportation to effect the removal of *shayl* produce from the borrower's field. He must store the delivered produce pending its disposal on the market and again pay the cost of transportation to the market; expenses and losses due to storage loom large among the many hazards of the region. A staff must be maintained to do all this work and roam the countryside on collection and check-up duty.

Frequently, the creditor uses the services of a "guarantor." Theoretically, the guarantor -- usually a man of better financial position than the borrower and linked to the lender by an informal arrangement to perform this chore whenever needed -- is brought into the picture as a cosigner of a loan granted to a borrower weak in resources and credit standing. However, he is not really expected to be responsible for the loan in case of default. He is used first of all to witness the transaction itself if the borrower cannot sign his name, and secondly as a means of impressing the borrower with the seriousness of his obligation. If default does occur, the guarantor will be sent to exert additional pressure on the delinquent or ascertain the validity of his excuses. If the borrower's plea is accepted, the guarantor will merely be required to cosign a loan renewal without any firming in his commitment. For all this he is paid a commission by the lender; thus another expense burdens the interest collected. (In some cases the borrower may also be forced to compensate the guarantor, usually by doing some work for him.)

Some of the "services" which the creditor supplies are technical; for instance, he will often supervise and advise the cultivator during the crop season and at harvest time so that the work is done with care and efficiency compatible with the lender's stake. (Supervision at harvest time is also intended to make sure that none of the debtors conceal, or abscond with, the mortgaged crop.) Other services are of a nature which transcend the immediate commercial relationship between lender and borrower. By communal tradition the borrower is not merely a "client" but in many ways a social responsibility of the lender. The latter may be expected to lend extra money for medical emergencies, weddings, birth ceremonies, etc., regardless of the status of outstanding loans. It has already been mentioned that the lender must, under pain of communal ostracism, make further loans to a delinquent cultivator -- even though he might be ready to write off the debt -- if the cultivator's livelihood depends on it. This is but one aspect of the moral obligation which moneylenders by tradition and sometimes also by inclination accept once a steady credit relationship has been established. Lenders are known to have continued making interest-free loans to old customers long after they have retired from business, knowing that the cultivator had come to depend on the annual recurrence of the loan and would perish without it. Sometimes they will set aside money for the specific purpose of continuing certain more or less charitable loans to old clients, and may pass on this commitment to their heirs.

Finally we come to another aspect of the lender-borrower relationship in the Sudan and other parts of the Middle East that is well known yet often forgotten. In accordance with traditional practices fostered by the Islamic prohibition of interest, the lender considers himself not a banker but a partner of the borrower. Even the Western world has no clear concept as to what the "proper" reward of the purveyor of equity capital in a given risk venture should be. One may argue in reference to the Sudanese lender that he labels himself a partner only to circumvent the laws of state and religion; yet when one considers the many social and communal obligations which surround him one can hardly call him a "lender" in the Western sense.

## Conclusion

Such, then, would be the arguments adduced by a Sudanese moneylender in justification of his business practices. It is unfortunate that no actual business accounts were accessible for study so as to make possible the presentation of the actual profits and losses of moneylending; but in view of the many intangibles in the transaction between lender and borrower, it is doubtful whether figures could tell the whole story. Government officials recognize a need for vigorous programs to provide rural communities with inexpensive, socially orientated credit facilities aimed at displacing the private lender. But they know that such reform cannot succeed without changing some of the cultivator's modes of living and thinking. They know that it will be difficult to replace the intimate knowledge, the social niche, the supervisory work in lending and recovering loans which the village merchant can give. They know that city banks would laugh off most of the loan applications the rural moneylender accepts every day as a matter of course. They know that even at their most charitable level, state and cooperative credit agencies may find it difficult to render the "social" services which moneylenders often give to their client. Nor can they easily cope with the rural borrower's ingrained distrust and dislike of institutions and red tape as effectively as the moneylender has done for centuries with his personal and informal touch.

Attempts to provide the rural dweller with credit facilities devoid of the well-advertised excesses of private moneylending have very often been disappointing. Some will ascribe this to ignorance and fear. But quite a few thoughtful observers tend to suspect that the reason may be the farmers' appreciation of a relationship whose full extent no accounting by double entry can show.

[Extracted from The Middle East Journal Vol. IX, 1955, pp. 139-46. Published by the Middle East Institute, Washington, D.C.]

# The Pitfalls of Specialized Farm Credit Institutions in Low-Income Countries

J. D. Von Pischke

[Why are specialized farm credit institutions founded in low-income countries, and why do they frequently founder? This phenomenon of development finance is explored by analyzing their performance problems, using financial logic and elements of political economy.]

Specialized farm credit institutions (SFCI) primarily engage in the provision of loans to persons undertaking agricultural production. They have names like Agricultural Development Bank, Agricultural Finance Corporation, Rural Development Bank, Agricultural Credit Corporation, Supervised Credit Agency, Land Bank and similar titles. In comparison with other financial institutions, their distinguishing features are a loan portfolio consisting almost entirely of agricultural loans, and a narrow range of financial services offered. For example, SFCI do not on any significant scale accept savings deposits, provide money transfer services, store valuables for safekeeping, or serve as fiduciaries, except when these functions are required in the processing of loan applications and in loan administration.

SFCI are established by governments in low-income countries to provide financial assistance for expanding agricultural production. They may cater to specific target groups of farmers based on farm sizes, or on their crops; and they are sometimes linked with land tenure classifications or reforms. Their services may be directed towards beneficiaries of projects for agricultural settlement, or compre-

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hensive rural area development. These institutions are usually expected to provide an impetus to agricultural innovation, and to promote certain social aspects of rural development policy - often in the small-farm subsector. Development assistance from foreign donor agencies often plays an important role in the design, establishment, financing and staffing of specialized farm credit institutions, and in their reorganization and rehabilitation. The World Bank's cumulative lending for farm credit approximated US $2.1 billion by 1978, and very substantial sums have been contributed by U.S. AID and the European donors as well as the regional development banks. Much of this agricultural lending has been directed into SFCI.

Specialized farm credit institutions in low-income countries have a checkered record as financial intermediaries. Their efforts to achieve institutional and financial viability and to expand their clientele encounter more complications than those of more diversified lenders because of the vagaries of agricultural production and prices, and also because a certain portion of their activities have more in common with social welfare activities than with commercial practice. Losses appear to be larger than would be expected from normal credit institutions. These lenders often find it difficult to achieve loan recovery levels sufficient to break even financially.

### Why Are SFCI Created?

The assumptions behind the creation of SFCI are that the agricultural sector (or the subsector in question) is not well served by existing credit institutions, and that most rural families (or a target group in question) do not have direct access to financial services provided by the formal, usually urban-based institutions. It is assumed that the formal financial market, although not highly developed, is loss-avoiding, rational, and workably competitive. It is also assumed that policy makers believe that supplying credit for agricultural purposes, or for the subsector -- i.e., the cultivators or target group in question -- would be advantageous. This belief consists of four related assumptions or ways of viewing rural people, the state of agriculture, the requisites of rural development and the role of government. The first is that "farmers are poor." Of all target group characteristics, poverty is singled out as of primary interest. The second, "the farm credit need-creed", holds that little agricultural innovation or progress can occur without access to credit, so that poor farmers "need" credit. The third is the axiom that government should promote rural development or target group welfare. The fourth is that "supply-leading finance" can stimulate agricultural and rural development and contribute to target group productivity. This term, evidently coined by Hugh Patrick in 1966, suggests the antithesis of the more usual observation that, "Where enterprise leads, finance follows". Supply-leading finance consists in providing funds in advance of demand in an effort to stimulate risk taking by borrowers in socially useful activities. In agriculture it is based on the assumption that when credit is tied to new practices, such as improved inputs or a new crop, it will accelerate the adoption of an innovation by the target group of intended borrowers.

The "public sector farm credit complex" thus defines the rural development problem in terms of the poverty of farmers and their lack of access to credit for specified purposes, finds the problem one which ought to be solved through public sector intervention, and specifies credit as a medium through which political initiative may be exercised. Supply-leading finance responds to the perceived poverty of farmers as well as to the belief that access to credit is necessary and will lead to an acceptable rate of material progress.

## Interaction of Interest Rates and Access

The public sector farm credit complex has produced advocacy of cheap farm credit. Its proponents state that credit should be provided at a "reasonable" rate of interest for purposes which are considered socially and economically imperative, and for target groups viewed as poor and having little alternative but to use credit if they seek to progress. Since informal market interest rates -- i.e., those charged by traders or other local moneylenders, but excluding kinship and friendship loans -- are high compared to those found in formal markets, the possibility of involving informal lenders in the solution to the problem defined by the public sector farm credit complex is not seriously considered; and this would not be feasible within the low interest rate structure proposed, as their costs would be too high.

What constitutes a "reasonable" rate depends upon local circumstances. Proposals often advocate loan rates like those that commercial banks charge on loans to commerce and industry. One argument raised against charging higher rates for agriculture is that it is objectionable to charge a high rate to the most disadvantaged people in society. A similar position is that low rates of interest help to compensate farmers for their losses of income from government price ceilings on food products (to help consumers). The usual result is agricultural interest rates below or roughly equal to the going rates on loans to other major sectors, or to individuals not dependent upon agricultural incomes.

Low formal sector interest rates on the types of loans most useful to rural people end, paradoxically, by restricting their access to formal sector financial services. Rural customers at low levels of financial activity are a costly market for a lender to serve.

They tend to deal in small transactions, which are relatively costly for a formal sector institution to process. They frequently are scattered geographically in areas with poor communications, making loan administration difficult. These factors inhibit the achievement of economies of scale by the lenders because of the small size of the market around a rural office. Rural people may not be accustomed to modern commercial practices, and often are not so concerned about loan due dates as other customers, which raises the lender's costs of loan and liquidity portfolio management. For deposit-taking institutions a clientele of small depositors, who conduct business in cash rather than by some form of payment order, requires that offices maintain relatively high levels of cash. Cash kept to meet depositors' demands earns no interest, adding to the costs of serving these clients.

The rural economy fluctuates more widely than many other types of financial activity. The marketed or cash-generating portion of agricultural output is subject to even greater uncertainty, as it is a residual left after the relatively constant subsistence requirements of farm families are satisfied. This variability in income tends to reduce lenders' evaluation of the debt capacity of the target group, which in effect is based on that portion of expected future resources that would be available for loan repayment in situations of reasonably expected adversity. Such situations include a certain proportion of poor harvests due to natural factors, low prices, and failures in the marketing system's capacity to absorb produce. Lenders' rationale rests on the requirement to meet the demands of their depositors and other creditors. An unpredictable stream of loan repayment collections increases lenders' liquidity requirements, which raises their costs and reduces the supply of funds they are willing to lend.

Uncertainty concerning the amount of a borrower's future cash flow which will be available to service debt is viewed by the lender as a credit risk. One determinant of willingness to bear this risk is the interest rate, which affects the income lenders can expect from the class of transaction concerned. Loans involving substantial degrees of uncertainty tend to be avoided by lenders unless they can charge high interest rates. When interest rates (used here to denote all fees levied by lenders) are kept low, lenders are not encouraged to expand their markets into activities which incur higher costs -- including the costs of greater uncertainty. A number of institutional factors inhibit lenders from raising rates selectively for individual borrowers to offset the costs of accommodating the more risky loan applicants. These include usury laws, the danger of increased political exposure, the size of the increases required, possible losses in economies of standardization of lending terms, and the costs of obtaining the information and expertise necessary to contain the risks of marginal business. Low rates thus encourage lenders to stringently ration credit according to commercial criteria of credit-worthiness.

The stringent credit rationing by existing financial institutions results in severely restricted rural access to financial services. This is seen in the paucity of rural offices of banks; in loan security demands beyond the capacity of most rural households; in minimum transaction sizes and minimum deposit account balance requirements which are high relative to transactions and incomes normal for rural areas; and in other arrangements or requirements imposing significant transactions costs on those seeking access to formal sector financial services. Adherents to the "public sector farm credit complex" perceive in this situation grounds for remedial government intervention by establishing a special-purpose farm credit institution. This lender is intended to be used to overcome alleged weaknesses in market performance, and is therefore not designed to be dependent upon market resources. It is funded through the national treasury -- frequently with support from external nonmarket sources such as foreign aid agencies.

By definition, a specialized farm credit institution is highly selective in the types of financial services it provides, operating on only one side of the rural financial market. Credit access is considered the primary problem, and so deposit-taking and money transfer services are typically not developed. Rural savings capacities and liquid resources are usually thought to be small. Institutions already in place, such as post office savings banks or commercial banks and cooperatives, may be thought to be providing adequate financial services outside the credit sphere. Policy makers may not see any advantages in replicating facilities or stimulating competition for rural deposits or money transfers. In addition, these services require managerial and accounting performance of a higher order than those of loan disbursement, and there are merits in opting for simplicity initially.

## Effects of One-Sided Intervention in Rural Finance

Intervention solely on the lending side of the rural financial market has consequences which are frequently overlooked. It tends to fragment these savings further: the credit channels are unrelated to the savings channels, and make little direct contribution to stimulating rural savings. Such intervention may encourage a popular belief that formal sector credit is essential, or is at least the most feasible means of progress, a view which could prevail at the expense of traditions of self-help and self-finance, and of the development of informal financial mechanisms such as rotating savings and credit associations.

Most importantly, dependence upon the national treasury and external donors limits SFCI access to market funds, and to the local information that it would have if it performed other roles than that of supplier of funds. Lack of such access results in alienation of the institution from the communities it serves. Alienation stems from inability to act as a rural financial institution, intermediating between rural savers and borrowers, rather than merely serving as a one-way link between the government and rural sectors. Rural people are not regarded by SFCI as a market to be developed, but are seen as poor, exploited or economically incompetent people requiring assistance. Rural people, in turn, do not view SFCI as something of their own, but rather as a benevolent instrusion to be exploited. In these circumstances a specialized farm credit institution is not well positioned to learn about rural financial flows, behavior and local priorities -- knowledge which is available only to those who enjoy sufficient confidence and operate on both sides of rural financial markets. Lacking such information and insight, and divorced from the context required to view finance broadly or creatively, SFCI management can develop only limited decision-making expertise. SFCI are not in a position to be stimulated by either the discipline imposed or the opportunities offered by market participation.

Without detailed information about the mechanics of rural finances, and limited by budgetary and operating constraints imposed by government sponsors, the specialized farm credit institutions generally are forced to allocate or ration credit by methods different from the commercial criteria applied by other financial sector intermediaries, such as commercial banks. Political criteria of some sort, broadly defined, are inherent in farm credit programs when designed by governments and development assistance agencies seeking to promote the welfare of target groups selected by non-market criteria.

Credit rationing by SFCI tends to take two forms, which may be termed intensive and extensive. Intensive credit rationing involves the identification of a relatively small target group, and the provision to members of that group of amounts of credit which are large in relation to the existing scope of their operations. For example, a farmer with two local cows may be given a loan to buy several high grade or exotic cows. A small farmer planting local plant varieties and using only a little organic fertilizer may be issued credit, possibly in kind, to plant his entire holding with high-yielding varieties nourished by chemical fertilizers. A farmer using bullocks for draft power may be accorded a loan to purchase a tractor. Or smallholders without a cash crop may receive tobacco planting materials on credit, plus a loan to construct a curing shed.

Intensive credit rationing has features attractive to aid agencies, and it is often found in externally funded SFCI activities. The usual objective of intensive credit rationing is to increase agricultural production and the incomes of borrowers through technological innovation. Because the size of the loan is such that borrowers could not reasonably be expected to repay it with their pre-loan cash flow, loan repayment must come from an increased cash flow to be generated by the loan-supported investment. Credit allocation under these circumstances tends to be quite selective in the choice of borrowers, and elaborate mechanisms using farm budgets are frequently employed by lenders to determine which farmers will qualify. An assumption underlying intensive credit rationing is that lack of finance is the binding constraint to increased production and augmented farm incomes. If so, this implies that all other elements essential to the realization of these objectives, including the ability to accomodate the uncertainties involved, are in place, or that they can be provided as an adjunct to credit and can be rendered operative by finance. Intensively rationed credit is supply-leading finance *par excellence*.

Extensive credit rationing is motivated by considerations of increasing credit access as well as production. Credit is allocated extensively to large numbers of farmers in broad target groups. For example, all members in good standing of a cooperative may have access to seed and fertilizer loans. All commercial growers of wheat having land titles may be eligible for production loans. Within SFCI budget or balance-sheet constraints, however, broad access implies relatively small loans to numerous borrowers. Loan limits under extensive rationing are frequently specified in terms of rules of thumb or standard amounts per hectare of credit-supported enterprises, in contrast to the more complicated derivation of loan limits from farm budgets used for intensive credit rationing. Extensive rationing is most frequently found in seasonal input credits. Small amounts are issued to each borrower, satisfying the production-oriented bias of program planners while also inspiring broad appeal which is politically desirable. Programs using extensive rationing are usually funded by governments without support from donors except in donor-supported area development projects, in certain aid for cooperatives, and in farm credit systems funded through centralized rediscounting agencies.

Each variety of stringent credit rationing under political criteria contains potential seeds of its own financial destruction. These seeds take root to the extent that politics produces extremes in credit rationing which overwhelm financial considerations. Programs with either highly intensive or highly extensive rationing self-destruct most rapidly, other things being equal.

Intensively rationed credit attempts to perform the function of equity or ownership capital in absorbing the impact of uncertainty. Intensively rationed loans are large relative to the financial status of the borrower, impose relatively large fixed debt service burdens, and change the on-farm factor mix significantly through the addition of higher levels of technology. Such loans can push the borrower's finances beyond his managerial and risk-bearing capabilities, especially during the critical initial learning period of adaptation to credit-supported change. Adversity can be reasonably anticipated in agriculture generally and especially in the implementation of new technologies. In periods of adversity, borrowers may find it difficult to meet debt-servicing obligations. The new activity may not generate sufficient cash flow to repay the loan which permitted its adoption. Delinquency in repayment easily results. Borrowers, however, may not regard transgression of government SFCI loan contracts very seriously: they may accept the public sector farm credit complex and view the lender as an alien institution with access to the tremendous resources of government.

Extensive credit rationing can also lead to financial problems. In promoting wide access to credit, lenders offer it to some borrowers who are not in a position to use it wisely, or who have little intention of repaying, or who are so exposed to uncertainty or so close to subsistence that even small repayment obligations assume major proportions. In these cases, an accumulation of arrears on the lenders' books is probable. For others who borrowed with the expectation that their agricultural incomes would be increased, the small sums of extensively rationed credit may present limitations. Prescribed husbandry practices which lenders intend to support may be subject to indivisibilities far beyond the actual loan size. For example, the loan may be small compared to the financial requirements of improved input packages, which can lead to incomplete adoption of the package with disappointing results. Improved seeds without enough fertilizer, for example, may not perform much better than traditional varieties. In these cases the borrower may not produce an incremental cash flow sufficient for loan repayment. Access to extensively rationed credit, therefore, does not necessarily stimulate adoption; and the loans may be too trifling to engender commitment to either their productive use or repayment.

Rationing by political criteria where borrowers are a favored faction easily leads to poor loan discipline, which can include delinquency, deceit and diversion. All these constitute a breach of a loan contract. Delinquency denotes the failure to repay on time, and inability or unwillingness to undertake repayment rise as credit rationing becomes increasingly intensive or extensive. Deceit arises because borrowers have an incentive to circumvent the rules of the game, especially rules made by a lender alien to them and thought to have huge financial resources, (presumably rationed according to political criteria). Incentives to build a good credit rating are lacking, especially in the early years of an institution when its permanency and efficiency have yet to be demonstrated.

Some of the ways of circumventing loan limits per hectare under extensive rationing are to apply for credit for a larger area than will be cultivated, or to borrow simultaneously under different names. Another is to borrow using a different name each season. If loan repayments are deducted at source from delivery proceeds, there is an incentive to borrow and deliver under different names, or to use other delivery agents. These tactics are often successful when loan supervision and records are not finely tuned. The relatively large size of intensively rationed loans may tempt the borrower to divert a portion for purposes not envisaged by the lender, especially if the borrower is not entirely comfortable with the leap in risk and managerial demands which agreed loan use involves. Loan-supported purchases or disbursements in kind may be resold for immediate cash, or fictitious invoices may be submitted by accommodating suppliers. Diversion is probably even more common under extensive rationing, especially when loans are disbursed in cash.

Repercussions of poor loan discipline for the SFCI: Poor loan discipline impairs SFCI development. Funds which would have become available for relending as outstanding loans mature are locked up as arrears. As arrears accumulate, SFCI resources fail to revolve full circle. Potential new borrowers may increasingly find their access to credit delayed, restricted or denied because of the declining liquidity of the lender. When funds available for lending decline, intensively rationed credit becomes available to fewer new borrowers. Lenders may restrict access still further by increasing the average loan size to lower costs in loan administration, thus catering to an increasingly select group of relatively low-risk, large borrowers. Lenders of extensively rationed credit, on the other hand, may maintain broad access by reducing average loan size. The causes of arrears may be fortified as these loans become increasingly trivial, especially in real terms when inflation raises the costs of modern husbandry.

Arrears have an opportunity cost. Funds that are not repaid cannot be lent at interest. Day-to-day collection problems consume the time of lenders' scarce managerial personnel, often at the expense of activities requiring a long time horizon such as planning, the development of management information systems, staff training, and designing more effective services for rural people. The accumulation of arrears and associated poor financial performance may demoralize staff members who have a financial or accounting outlook, making it even more unlikely that the institution could become financially efficient. In the rural communities affected, overcoming the reputation of poor loan discipline by government lenders is difficult and has its own cost. Private financial intermediaries outside the state sector may be deterred from serving the poor because of bad repayment habits. They may be increasingly reluctant to extend credit in experimental or innovative ways because of the heightened political sensitivity surrounding the enforcement of rural loan contracts.

Furthermore, the achievement of development targets may be hindered by poor loan discipline. Defaulters, originally considered as poor farmers deserving financial assistance, are placed in an adversary position against their financial partner in development; the flow of communication between borrower and lender is constricted. A basis for distrust is created between borrowers and rural development administrators, extension agents and SFCI staff. Distrust inhibits all rural development programs by making consensus and cooperative action more difficult to achieve, or by requiring the exercise of great force for the successful implementation of programs involving rural participation. Attempts to reduce defaults by extra-legal administrative recourse against defaulters might have some success, but it increases the probability of arbitrary action against rural people and adds to distrust.

Widespread unapprehended default demonstrates to rural people that government is not able or not willing to enforce contracts. But cases taken to court by SFCI to obtain enforcement may strain the ability of courts to dispense justice, especially if defaulters are numerous. The legal force of other contracts may be compromised by situations created by loan defaults, which could retard commercial advance and the contribution this makes to rural development. The accumulation of arrears also makes SFCI more vulnerable to political interference. Those who formed the institution to assist the rural poor and gain popularity are seldom enthusiastic about seeing their creation expropriate rural property, or use a black list of defaulters to be denied further credit. Interference may be across the board, forcing SFCI to permit all defaulters to take a longer free ride; or selective, favoring certain groups or individuals. Default may also be a source of conflict among rural people between those who strain themselves to repay and those who don't and fail to suffer for it. The selective nature of credit access may be magnified by selective default "privileges", i.e., by uneven efforts to enforce loan discipline. To the extent that the pattern of default mirrors the rural power structure, equity is violated by manipulation of collection activities. Thus, the initial concern for access when expressed through an inappropriate medium can end by violating the concern for equity.

## The Future of the Public Sector Farm Credit Programs

The preceding description, while accenting the negative possibilities, nevertheless reflects the experience of SFCI in a wide range of countries in one degree or another. Some programs are more severely affected than others, but few can claim a complete immunity to the dangers concerned.

In view of the problems which plague specialized farm credit institutions in low-income countries, what is their future course? One certainty is that agricultural and rural development programs will continue to receive large amounts of funds from their sponsor governments and foreign aid donors because of their economic and political appeal, and much of this will go into credit. Less certain is the survival of particular SFCI, and the public sector farm credit complex in general. Four major influences may work against it. First, it will be rendered irrelevant in some countries where strong centralized control of agricultural production and of rural people, and the transformation of the formal financial sector into a set of accounts for the planning authority can eclipse the concerns of more gradual reformers. Second, rural development breakthroughs not involving supply-leading finance are likely to divert attention from the credit complex. There are several possibilities of this kind.

Third, the intellectual position of the complex will be eroded in some degree by trends apparent in recent research or rural financial markets. Assumptions which are increasingly challenged by empirical data are: that rural people are unable to save; that rural financial liqudity is negligible; that the informal credit market is characterized by "usurious" rates of interest; and that specialized farm credit institutions and low interest rates are low-cost government activities serving the best interests of rural people. Finally, the complex can be undermined by the practical success of farm credit suppliers which operate effectively in financial terms in ways which are at odds with the complex. These could include aggressive efforts to mobilize target group deposits, and techniques of support which concentrate on building viable financial institutions not dependent on subsidy, as opposed to low interest rates for target groups.

[Adapted from an unpublished paper.
The views expressed are those of the
author, and should not be attributed
to the World Bank.]

Editorial Comment: This presentation has concentrated on the shortcomings in small farmer credit institutions as they often operate.

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The dangers described are all too evident in the actual record of SFCI in a variety of countries. It seems worthwhile to attempt a statement of some of the positive inferences that could be drawn from this exposition of weaknesses and the reasons for them.

We may focus on the weakness of the SFCI as financial institutions as the heart of the matter: they should become viable, sustainable operations, covering their costs and collecting their debts. (Others may have different ideas of what is most important among the various intereacting elements in farm credit operations, but this focus appears to this editor a useful way of pulling the elements together.) To avoid financial losses, a lending institution must do two difficult things: 1. charge enough in interest or fees that its income will cover its costs; 2. gain sufficient respect from the farmer-borrowers that they will repay loans unless truly prevented from doing so by adversity.

To charge high enough interest rates on loans requires a clear recognition that small rural loans are by their nature a high-cost activity; they are not lower in cost than lending to richer people in urban areas -- as the village moneylenders have discovered (see preceding article). It also requires governments to recognize that subsidizing low-interest loans to farmers is not a way to solve rural problems in any sustained way. At best, they can introduce a few farmers at a time to new practices by temporary subsidy; but they cannot afford to keep all their poor farmers on indirect subsidy for long (most of it won't reach the poorer people anyhow). So, having confronted these realities, governments ought to put their efforts and resources into launching institutions that will be self-supporting, and/or motivating private banks to serve rural areas more adequately and profitably.

To gain respect from borrowers is a tricky business, harder to prescribe for; different cultures, and situations will no doubt call for differing tactcs. But in all cases the requirement is that borrowers must value what the credit institution can and will do for them (beyond the cash obtained from a first loan). Therefore, specialized farm credit institutions need to examine themselves from a borrower standpoint, and take actions accordingly -- a most difficult feat. In most instances they should provide services better adapted to rural conditions, while also working on cost reduction, and should try to attract savings along with lending. Their technical contributions to farming, where these are associated with credit, must be of demonstrably practical value to borrowers. And their management style must be right -- whatever that may mean locally. These things apply whether credit institutions are public or private, and whether they deal directly with farmers or work through cooperatives or other intermediaries.

These views are the editor's, not necessarily shared in all respects by the U.S. Agency for International Development. They are, of course, stated briefly, and thus may not suggest the complications involved in doing what they call for. The case for striving to do as much as possible can be inferred from the account given in the preceding article of the hazards of starting from inappropriate assumptions and moving in directions where weaknesses grow up, and one problem leads to another. SFCI in many cases seem not well formed for the job they ought to be doing; but while there is a case for their elimination, I am not certain that anything better would necessarily appear in their place. My view would favor reshaping rather than abolition.

Gordon Donald, Editor

# Financing Rural Non-Farm Enterprises in Low-Income Countries

Richard L. Meyer

[A neglected element in rural development is the support of nonfarm activities. These have been generally short of capital, among other things; credit institutions should develop more innovative approaches to adapt their services to the needs of small enterprises.]

A number of low-income countries, especially in Asia, are currently placing increased emphasis on off-farm employment as a means to alleviate rural poverty. Although improvements have been made in some countries in rural incomes, there is a growing frustration about the limited impact made by past strategies in materially improving rural welfare. Capital-intensive industrialization has failed to generate significant increases in employment to absorb the available labor supply. Technology-oriented agricultural development strategies have eased food constraints, but the supposed trickle-down of benefits to small farmers and rural workers has been limited. Although some small farmer programs appear promising, most have yet to demonstrate a significant impact on the poverty problem. Their scope has been limited, and it is not clear how far these pilot programs can be generalized to all the rural poor. Policy makers are therefore turning to off-farm employment as an additional measure to improve incomes of farm households.

As development strategy shifts in this direction, a logical question must be: how can the small-scale sector be assisted? In many countries, a viable small-scale sector is dependent upon a

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deliberate restructuring of the current rules of the financial game which favor large-scale firms. Once having achieved such a restructuring, however, the question still arises as to what specific programs and policies can be designed to facilitate the creation and expansion of small-scale firms. The purpose of this paper is to review the financial needs of rural nonfarm enterprises and analyze how rural financial markets can better serve these needs.

## Off-Farm Work and Rural Nonfarm Enterprises

Before discussing finance, it is useful to briefly summarize some of the recent literature concerning the rural nonfarm sector. Two research themes are most relevant. The first concerns the nature and extent of off-farm work for rural households. At one time, this issue was largely ignored by agricultural economists; part-time farming was seen largely as a transitional phenomenon. Part-time farmers were viewed as a problem in efficient resource allocation, and policy was largely directed toward speeding their adjustment from part-time to full-time status.

More recently, however, the part-time farm household has begun to be viewed with more interest as a possible permanent fixture of the rural setting. In such widely divergent settings as the U.S. and Japan, rural residents typically earn a wide variety of incomes from both farm and off-farm sources. In the U.S. the proportion of farm household income derived from off-farm sources grew steadily from 43 to 59 percent between 1960 and 1976; in Japan this proportion grew from 48 to 62 percent from 1964 to 1975. The importance of off-farm income is much larger for small farms. Over 80 percent of the household income of U.S. farms selling less than $2,500 in gross sales come from off-farm sources in 1976, up from 60 percent in 1960. In Japan, farms with less than 0.5 hectares in 1973 earned almost 90 percent of household income from non-agricultural sources, while that percentage was only 30 percent for farms over 2.0 hectares. And the importance of off-farm work is not limited to high income countries. Farm records, surveys and village studies in such widely divergent areas as Thailand, Taiwan, Korea, Sierra Leone, Nigeria and Egypt show that farm families allocate their time to and receive income from a wide variety of off-farm or nonfarm activities. Problems of rural-urban income gap and rural income distribution would be much worse if low-income rural households did not engage in such off-farm activities.

The second increasing theme found in the literature concerns the nature, extent and potential of nonfarm enterprises in rural areas. In many countries 20 to 30 percent of the rural labor force is engaged primarily in nonfarm work. In Asia the share was reported as 51 percent in Taiwan in 1966, 40 percent in the Philippines in 1970, and 25 percent in South Korea in 1970. One-half to two-thirds of all nonfarm employment opportunities in Asia were found in rural areas and towns. Likewise, small-scale firms, the majority of which are located in rural areas, represent a major share of total employment in several industries. For example, Oshima found for the Philippines in 1961 that firms engaging fewer than ten persons comprised 93 percent of the employment in construction, 94 percent in commerce, 76 percent in manufacturing, 64 percent in transport and communications and 95 percent in services. Several studies that have tried to assess the characteristics of different sized firms suggest important advantages for small-scale enterprises. They (1) are less capital-intensive; (2) are more geographically dispersed; (3) offer more opportunities for unskilled and family labor; (4) have greater linkages with the agricultural sector; and (5) have greater export potential than frequently assumed. It is concluded that expansion of small-scale firms would be more consistent than large-scale capital-intensive firms with the current resource endowments and state of development of most low-income countries. These results lead many persons to argue that more attention should be directed to the small-scale sector. But the question arises, what can be done to assist small-sector enterprises?

## Assistance to Small-Scale Enterprises

Most countries employ a variety of industrial promotion techniques including customs exemptions, preferential foreign exchange rates, tax incentives and concessionally priced credit. Unfortunately, these techniques are principally geared to large capital-intensive firms, and small firms frequently do not or cannot benefit. Some promotional efforts must be pinpointed more specifically to their problems. The specific needs and approach will vary from country to country, but a number of options have been suggested:

(1) Infrastructure - Social and economic infrastructure may make a substantial impact on the development of nonfarm activities. Rural areas typically lack communication, transportation, electricity and other facilities. Infrastructure requirements may not be very sophisticated: dirt roads may be adequate, rather than paved highways; diesel generators may serve as well as electrical grids. Small-scale facilities can be more easily located where specifically needed.

(2) Trading services - Small firms frequently lack adequate input and product markets. Healthier cooperatives or trade associations can help in obtaining a steady

supply of lower cost inputs and quality products for domestic sales and exports.

(3) Research and technical assistance - Much of the research in many countries is conducted in urban-based institutes with results that have limited relevance for small rural enterprises. Some of this research could be better located in rural areas, where it would be more directly accountable to intended clientele. Nonfarm extension services could be developed, similar to existing farm extension programs, to encourage the spread of innovations.

(4) Vocational training - A large amount of training occurs in small-scale enterprises through apprenticeships and on-the-job training. Formal vocational training should be complementary, providing basic instruction in management, record keeping, marketing, etc., as well as certain specific skills like baking, welding, carpentry, printing, etc.

(5) Industrial estates - Providing services over wide geographic areas can be prohibitively expensive. Several countries have tried to achieve economies of scale by creating industrial estates. These estates provide infrastructure and facilities, and some even provide building shells for firms. The Indian experience shows, however, that high-cost, poorly located estates will not be fully utilized.

(6) Financial services - Finally, most studies identify credit and other financial services as a constraint and propose credit programs and/or institutions for nonfarm enterprises, frequently in conjunction with technical services.

Existing financial services. The literature clearly suggests that small-scale firms suffer from inadequate institutional financing. Three types of evidence are frequently given in support of this claim. First, small businessmen customarily identify finance as one of their key bottlenecks when asked about their business. In fact, their management of limited capital might be the real problem, or they might think the questioner can help them get funds; nevertheless they frequently perceive that inadequate finance is the major reason for their limited profits.

Second, small enterprises are frequently started and later expand largely with equity capital obtained from savings accumulated from other activities, or from within the firm itself. For example, Liedholm and Chuta report that approximately 60 percent of the funds used to establish small-scale industries in Sierra Leone came from personal savings from agricultural activities, trade or business. The 1973 Accra manufacturing survey showed that over 90 percent of the firms were started using personal savings or loans from relatives. On the other hand, debt capital frequently plays a more important role in the finance of larger firms in many countries. The limited use of credit by small firms can be seen as evidence of discriminatory credit rationing, especially if it can be determined that the small firms in question are profitable and appear to have potential for expansion.

Third, when credit is used, it frequently is obtained from informal sources (other than friends and relatives) such as input suppliers, purchasers, and moneylenders. The interest rates charged are usually higher than those charged by formal credit sources. For example, Kochov et al. report that small industrial enterprises in Korea borrow at rates of 35 to 40 percent from informal sources, compared to 17.5 percent from official banks, while in Colombia the informal rates are 36 to 60 percent compared to the official 24 percent. Thus, it is concluded that small businesses are denied adequate formal credit and are forced into higher-cost informal sources.

Supply constraints offer one plausible explanation for small amounts of formal credit use. Two other explanations from the side of demand also may be important. Complicated procedures inconvenient or uncongenial to borrowers are often introduced by lenders to assist in rationing scarce loan funds, especially when low interest rates are set. Thus, total costs to the borrower of obtaining small loans are far greater than just the interest on the loan. The supposed large differential between costs for formal and informal credit may largely disappear when total borrowing costs are compared rather than interest rates alone.

For other reasons, too, there may be little demand for bank credit by small-scale firms. The economic environment in which they operate may be so uncertain that there is little incentive for them to grow and expand. Input supplies may be uncertain and of poor quality. Product markets may be easily saturated with increased production. Management may be unqualified to handle a firm of greater size and complexity. In these conditions, assumption of loan repayment obligations may appear unwise.

Determining which of these explanations is most appropriate is a complicated undertaking beyond the scope of this paper. The answer will vary by country and by industry, and firms existing side by side in the same industry may have quite different credit needs so that their demand for credit will be different. There are a number of reasons on the supply side, however, which may explain a limited amount of credit offered to small firms. By understanding these reasons and working to relax the supply constraints, the demand issues will then be placed in clearer focus.

Factors affecting credit supply. Nonfarm enterprises in the rural areas may suffer from inadequate credit because of the heavy emphasis on farm credit in many countries. It is ironic that the more successful countries are in providing farm credit, the less successful they may be in supplying funds to rural nonfarm firms. Through regulations, quotas, rediscount arrangements, special funds and other means, a number of countries have tried to increase the flow of funds to farmers, and especially small farmers. When these efforts are successful, lenders may spend so much time, effort and funds to meet the farm credit objectives that they have little time or funds left for nonfarm enterprises. Some of these specialized lending institutions are even legally prevented from making nonfarm loans. Furthermore, lenders may experience low profit margins with farm credit, which could discourage them from making small nonfarm loans that may also have low profit margins. Low inflexible interest rates, set by custom or usury laws, contribute to insuring low profit margins.

Farms are heterogeneous, but in specific agricultural regions most farms will likely have broad similarities in technologies and production practices. Thus, lenders can develop procedures and rules of thumb to guide farm credit operations that will be fairly valid within the immediate area. Within that same market area, however, nonfarm enterprises can be expected to vary widely, perhaps including a blacksmith shop, bicycle repair, bakery, tailor, cement plant and textile firms, and there may be only one or a few of each. It is difficult for the lender, therefore, to acquire familiarity with each type of firm and understand their unique problems well enough to feel confident in granting credit and technical assistance.

Lenders generally perceive high risks in small enterprise lending, just as they do with small farmer credit. Small-scale businessmen almost by definition have limited reserves to withstand adversity. Although the small-scale sector may appear to have considerable resiliency as manifested by a wide number of firms, the turnover of firms and bankruptcies are often high. These firms can provide only small amounts of collateral, and the value of such collateral may be low due to the limited market for it in any one area. The success of small-scale nonfarm enterprises may be inextricably tied to the fortunes of farming: when harvests and prices are good, farmers have income with which to pay old bills and contract for new goods and services, but when yields or prices are poor, so is the market for nonfarm firms. Thus, loan repayment will likely follow a similar pattern for both farm and nonfarm firms, so that there will be limited opportunity for the rural lender to substantially reduce the risk of his total portfolio through nonfarm loans.

The administrative structure of some larger banks works against making many loans in rural areas. Lenders often give little authority to branch staff to make decisions on loans, as these are retained in the home office. The branch staff considers its function largely to collect and channel deposits to urban areas. Little effort is made to aggressively seek out loan customers in rural areas. The expected relationship between collecting deposits from clientele in return for possible loans breaks down, so one of the powerful motives for saving may also be destroyed.

Finally, the operational inefficiencies and attitudes of lenders may exacerbate weaknesses within the small-scale firm. Patel found in a study of innovations used to assist small-scale industry in Gujarat State of India that inadequate working capital from banks was a major problem, even though long-term finance was abundant from state sources. Capacity utilization and sales performance of the new firms studied were much less favorable than projected, due to shortages of working capital. The firms faced long delays in loan approval and disbursement, large margins, inadequate amounts allowed, nonresponse to needs at critical times, and a hardening of lender attitudes at the first sign of trouble. Clearly the banks were not as committed to the small industry promotion program as were the state authorities, and the effectiveness of the other components -- long-term finance, entrepreneur identification and training, and infrastructure development -- was thus blunted.

Directions for improvement. The limited amount of funds going to rural nonfarm firms, and the problems encountered by countries that have tried to increase formal credit supplies, suggest a need to rethink how financial services can be effectively provided in rural areas. Several issues need to be faced. 1) The current emphasis on implementing credit projects rather than strengthening rural financial markets contributes to fragmenting rather than integrating financial services. A few borrowers are favored by a specific project, while many are neglected. Services to firms outside the project may even deteriorate as staff and agencies strive to service project beneficiaries. Rural financial markets must be opened up to a wider range of clientele. Borrowing and savings services must be broadened. Some of the current rules, regulations and requirements must be relaxed, and appropriate incentives given to financial intermediaries.

2) Discussion has focused on the type of institution required to effectively provide financial services to rural nonfarm enterprises, but this issue is probably not worth all the attention

usually given to it. Studies of farm finance show a striking similarity in the performance of various types of institutions in a particular economic environment. The key issue appears to be the objectives and interests of institutions, not their particular form or ownership. For example, Costa Rica, Jamaica, India, and Bangladesh have nationalized commercial banks as a means to alter their performance. Yet studies suggest that these nationalized banks continue to serve approximately the same clientele as they did before nationalization. The nationalized banks tend to share most of the same performance criteria used by commercial banks, such as unit costs, profit margins and surpluses, and efforts to force nationalized banks to make loans which cause these performance measures to deteriorate will be resisted strongly. Fortunately, many countries have a fairly well developed set of intermediaries. The challenge is to develop an appropriate set of incentives so they service nonfarm firms, rather than create new special-purpose institutions.

3) More innovative thinking is required to reduce the cost and risks of lending to small farm and nonfarm firms. Lending procedures need to be streamlined, similar to deposit operations. Risks may be reduced through guarantee funds and loan insurance. Group lending experiments may suggest ways to reduce and improve repayment performance. The advantage of geographic proximity of lender to borrower needs to be more fully exploited in nonfarm lending. The lender can easily make periodic visits to the firm to assist with financial management. Loan repayments can be scheduled differently. For example, a bicycle shop may logically make daily or weekly loan payments which would be impossible for a farmer due to distance and seasonality of income.

4) Increased attention must be given to the terms and conditions of loans. Amortization schedules must be made more flexible. Incentives are required to encourage rapid payments, but simple provisions are also necessary for extending loans and scaling down payments when planned production and sales conditions are not met. Interest rates must be set at rates which reflect the true scarcity of the capital in the society and offer an attractive return to the lender. If temporary subsidies are required for the borrower, it is far better to provide them through means other than concessional interest rates which discourage lenders while encouraging borrowers into a more capital-intensive technology.

5) Training and technical assistance are required for both the lender and borrower. Lenders need assistance in improving loan services to keep pace with the efficiencies obtained by some institutions in servicing deposits. Loan officials need information on the problems and the potential of various rural nonfarm enterprises.

More efficient and knowledgeable lenders should be more inclined to make small loans to nonfarm businesses. The lenders need enough information about various types of firms so loans can be based on projected debt repayment capacity rather than exclusively on arbitrary rules of thumb or procedures. In turn, lenders could provide important noncredit services to borrowers. Most small businesses have little or no record keeping; lenders are logical sources of information for decision making. Indeed, this information might be more useful for the long term survival and expansion of the firms than the credit itself.

[Extracted from Problems and Issues of Agricultural Credit and Rural Finance, Proceedings of an international workshop on financial services to the rural poor, pp. 117-25. Published by the Agricultural Credit Department, Bangladesh Bank, Dacca, 1979.]

Laboratory of Quantitative Biology at Cold Spring Harbor, New York, a center for study of subjects like bacterial genetics. (Photo: Cold Spring Harbor Lab.)

# Microbiological Science for Development

Carl-Göran Héden

[The exploitation of beneficial microbes, and protection from damage by harmful microbes, have a great importance for human life in all areas. This article describes a new international network designed to help bring the gains from microbiological science to the developing countries.]

Humanity increasingly will have to depend on renewable resources derived from the biosphere it shares with plants, animals, and microbes. The exploitation of domesticated plants and animals has been successfully practiced since time immemorial, but it was only one hundred years ago that we started to learn how to exploit beneficial microbes, and how to defend ourselves against pathogenic microbes. The "domestication" of microbes requires more skill than the domestication of plants and animals, but its benefits are no less. At the moment these are reaped chiefly by the developed countries of the world. Most developing countries have not yet reached the state where they can take full advantage of this important biological research. Out of the 100,000 microbiologists now living, only a small percentage are found in the Third World. Yet applied microbiology is eminently suited to making important contributions to the fulfillment of basic human needs in developing countries.

## The UNESCO/UNEP/ICRO Program

UNESCO, the United Nations Environment Programme (UNEP), and the International Cell Research Organization (ICRO) -- a non-governmental organiza-

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tion -- have recognized how useful applied microbiology could be in the developing countries. This recognition has led them to forge a joint program whose aims are to help advance the growth of applied microbiology in the scientific infrastructure of the developing countries, and to promote development-oriented research activities in the technically advanced countries. The UNESCO/UNEP/ICRO microbiology program seems an appropriate practical model in the context of mobilizing technology for world development because:

(a) It involves the initiation and development of technologies ranging in scale from household to industrial, with emphasis on low-cost, low-energy technologies that are within the economic and technological capabilities of the developing countries. It makes a special effort to stimulate rural self-reliance;

(b) The guidelines followed by the program, developed from practical experience in the field, are in harmony with the principles formulated in the New International Economic Order;

(c) The program directly impinges on both scientific and technological infrastructures in a wide range of disciplines as a consequence of the strong interdisciplinary character of microbiology;

(d) The program's subject matter is restricted to a well defined area of applied biology in which an obvious backlog exists in developing countries.

## The Rationale of the Program

Bacteria, fungi, protozoa, algae, and viruses are all microbes, that is, very small organisms a few thousandths of a millimeter in size. Yet their total biomass is estimated to be of the same order of magnitude as that of plants and animals. Much of the activity of microbes is essential or beneficial to human life, but some of it is detrimental. Microbes are the oldest living organisms on earth and may be considered the ancestors of all other forms of life. Because of their special qualities, microbes play an important role in shaping the biosphere and man's place in it. Microbes are the main "pumps" in the cycles of carbon, nitrogen, oxygen, and sulfur, and are thus responsible for the steady composition of the atmosphere. For instance, 30 to 50 percent of all carbon dioxide converted into organic matter is consumed by photosynthetic microbes (in plankton) in the oceans, and some 90 percent of the carbon dioxide brought into the atmosphere is produced by microbes during the degradation of organic matter. If the latter process ever came to a standstill, the carbon dioxide content of the atmosphere would drop to zero within a century and plants would no longer be able to grow.

Thus, microbes are at the root of marine productivity and, at the same time, the main agents responsible for the natural decomposition of wastes. The technology of waste treatment, in fact, is essentially based on an intensification of this natural process by technical means; sewage treatment is the largest microbiological industry in the world. Another example is found in the microbial fixation of atmospheric nitrogen, which is counterbalanced by microbial denitrification leading to the loss of fixed nitrogen from soil and water to the atmosphere. These parts of the nitrogen cycle are of primary importance for soil fertility.

Beneficial microbes have been used unknowingly for centuries in many traditional processes in which food is preserved or altered in quality by judicious, semi-controlled microbial action, as in the making of wine, yoghurt, sauerkraut, and cheese. Many of these processes have been rationalized by the use of pure microbe cultures, or mixtures of selected strains, resulting in the production of an essential part of human food intake. Microbes even play an important role in the production of meat, since plant-eating meat animals depend on microbial activity in the stomach for the conversion of cellulose into essential nutrients. However, many traditional fermentation processes are still being practiced in some countries without the benefit of full scientific control, and hence are still subject to becoming health hazards and causing unnecessary losses in nutritional value.

The importance of microbes in food production has gradually become dwarfed by the rapid growth of the so-called fermentation industry, which over the past five years has successfully embarked on the production of such diverse products as alcohols, organic acids and ketones, amino acids, vitamins, drugs, antibiotics, vaccines, enzymes, and fodder protein (single cell protein). In Japan, for instance, this industry is now responsible for 6 percent of the nation's income. An important characteristic of the industry is that it consumes agricultural by-products which, if unused, would qualify as waste materials. The rising prices of non-microbial protein and of petroleum are now making the industry even more important. Meanwhile, we have also learned that microbes can be used in the control of disease in man, plants, or animals; mass-produced microbial pathogens for the parasite or the disease vector are introduced at strategic points. The environmental advantages of biological over chemical pest control are well known.

One of the major factors limiting food production, and often the chief factor, is the absence of nitrogen. In developing countries where the water supply is adequate, it is often the amount of nitrogen available to higher plants that determines the amount of food that can be produced. In many of the arid regions, lack of nitrogen is second only to lack of water as the main reason why crop yields are low. In the technologically advanced countries, much of the plant need for nitrogen is supplied by fertilizers. Fertilizer nitrogen is synthesized by the chemical industry; the cost of the fertilizer is low in comparison with the value of the food to the human population. In most of the developing countries, on the other hand, the relative cost of fertilizers is quite high, making it too expensive for small farmers. In many regions fertilizer is totally unavailable.

Microorganisms have a unique role in the nitrogen nutrition of plants. The reason is that some of these organisms carry out essentially the same function as the chemical industry, namely, taking nitrogen from the atmosphere (where it is unavailable to higher plants) and converting it to a usable form. This the microorganisms of soils do at no cost to the farmer, and with very little need for environmental manipulation. In some instances, the addition of selected strains of the nitrogen-fixing genus *Rhizobium* to soils or seeds can replace industrially produced nitrogenous fertilizer. (See Development Digest, October 1975, p. 18.) Promoting the growth of nitrogen-fixing algae can achieve similar ends in rice fields. Actions like these provide important savings in energy and industrial investment and at the same time reduce the pollution of water from fertilizer run-off.

Microorganisms are gaining increased recognition as alternatives to chemical pesticides. Most pest species have natural enemies within the microbial world, and it is known that the activities of microbial pathogens, parasites, and predators can be directed against agricultural pests and thus increase the production of food and fiber. Microbial agents of biological control are a welcome addition to the arsenal of weapons in our war against pests, and they are used increasingly in integrated programs of control.

Waste treatment is now mainly protective, but the more positive approach of turning wastes into useful products is receiving increased attention. Especially in the developing countries, existing processes like sewage farming and fish culture in waste ponds should be improved and made hygienically safe. The use of wastes in the aquaculture of desirable algae or plants is being explored and exploited. The following list of waste treatment processes which employ microorganisms to yield products of potential value is far from exhaustive: the production of fodder yeast on spent liquor from paper manufacture by the sulfite-pulping process; the production of "wheast", a nutritious food substance formed when lactose-utilizing microorganisms are grown on whey, a waste resulting from cheese manufacture; mushroom production on rice straw or compost; methane fuel formed by anaerobic digestion of animal manure or plant residues; and microbiological processing of cellulosic and starch wastes to enhance their nitrogen content and hence their value as human and animal feed.

The versatility of microbes is clearly demonstrated by their uses in the mining of ores of several metals. Mineral deposits and slag that cannot be economically exploited by conventional mining and chemical methods can sometimes be profitably extracted by microbial treatment. Acid production by specific types of microorganisms has facilitated the mining of low-grade ores of copper, zinc, and uranium, and microorganisms have assisted in the reclamation of oil from shale. Yeast has been used to remove undesired wastes from petroleum by a process which not only increases the commercial value of the fuel but also produces single-cell protein for animal feed.

The current public concern with limitations on the world supply of fossil fuels poses challenging possibilities for the creation of renewable sources of non-polluting energy by microbiological methods. The capacity of microorganisms to produce bio-gas, hydrogen, and methane has attracted particular attention, and several procedures have been developed for the formation of these substances from waste materials. Sewage grown on "energy farms" can produce ethanol obtained from sugar by fermentation.

The various uses of beneficial organisms are far from exhausted. Many new developments can be expected in the next decade as a result of genetic strain improvement by the use of immobilized enzyme technology and other imminent scientific and technological breakthroughs. Microbes play a vital role in the development of biochemistry, molecular biology, and genetics. Their small size and rapid multiplication, coupled with the fact that the entire living world possesses a basic unity, has made microbes rewarding tools for research in these areas.

Harmful microbes manifest themselves most clearly in infectious human diseases. Protective action has been most successful where an understanding of the principles of infection is prevalent in the population and is combined with curative and preventive medical treatment. Many diseases under control in the advanced countries are still rampant in the developing regions of the world. This was strikingly illustrated at the 22nd World Health Organization Assembly, where the delegate of one Asian government stated that waterborne diseases accounted for 60 percent of all morbidity and 40 percent of all mortality in his country. He estimated that 90 percent of the rural population (and 72 percent of the total population) suffered from intestinal parasitic infections, and that less than 10 percent of the total population had access to piped water supplies.

Microbial diseases in plants and animals have called forth defensive management in agricultural and animal farming, the outcome of which has a great impact on the precarious food situation in many parts of the world. Certain foods may contain pathogenic microbes or toxins of microbial origin even though their nutritional value has remained unimpaired. Salmonellae in meat or fish meal, and aflatoxins in peanuts, are examples. Developing countries that lack the microbiological expertise to prevent such contamination therefore cannot export such foods, since they do not meet health standards.

Besides pathogenic microbes, many other microbes can spoil foods and other valuable materials, ranging from wood to stone monuments. Food spoilage deprives the world's population of a large percentage of the world's harvest, and microbial corrosion and other forms of biodegradation cause annual losses in the millions of dollars. Knowledge of spoilage mechanisms and preventive action by canning, refrigeration, and other forms of preservation, as well as chemical protection, has reached a high degree of effectiveness in the developed world, however.

In short, microbes are of vital significance for human survival. The domestication of the microbe has developed relatively recently and is far from complete, even in the developed countries. In contrast to the domestication of plants and animals, that of microbes requires more basic general education, combined with specialized skills not readily transferred by the social mechanisms found in agricultural tradition. Successful handling of microbial strains, or even recognizing them for what they are, requires much more knowledge than growing a crop or raising cattle.

It is therefore not surprising that the developing nations of the world thus far have not fully profited from the microbial resources at their disposal. Through lack of basic education, expertise, and appropriate microbial strains, they are foregoing benefits that are available to the developed world while they remain exposed to the environmental hazards of harmful microbes. Developed as well as developing countries may expect to gain much from future developments in basic and applied microbiology, and developing countries can derive great benefits from the transfer and application of existing knowledge. It is, therefore, imperative that mechanisms be created to provide developing countries with locally useful strains of microorganisms, and with adequate training and research facilities for using them.

## Areas of Activity

The UNESCO/UNEP/ICRO program addresses itself to the following main subject areas:

(a) Registration and preservation of the microbial genetic resources of the world, and making them available to developing countries.

(b) The application of microbiological nitrogen fixation (*Rhizobium*, blue-green algae) so as to reduce the requirements for chemical nitrogenous fertilizers. The use of commercial fertilizers promotes eutrophication, and their manufacture requires large amounts of energy. Many countries have to import fertilizers, which requires increasing amounts of foreign currency.

(c) Microbiological methods for the production of food and fodder, including single cell protein as well as indigenous fermented foods. Food preservation and methods to counteract postharvest microbiological food spoilage.

(d) Use of microbes in management of the environment. Water and waste-water purification. Waste utilization and recycling, including bio-gas production and upgrading of cellulose wase by protein enrichment for use as fodder.

(e) Microbiological aspects of health problems in man, plants, and animals occurring as a corollary to microbial waste utilization and food production and the microbiological control of pests and disease vectors.

(f) The use of bio-technology for the full exploitation of available renewable resources at appropriate scales, ranging from the household and village levels to the industrial level, and geared to the promotion of self-reliance in the areas of food, fodder, fuel, and fertilizer, especially in rural areas. Application of appropriate technology and simple diagnostic and measuring equipment (field kits).

(g) Training of manpower and strengthening of infrastructures for research and for dissemination of applicable results on a national and regional basis. Promotion of microbiological societies and two-way interaction with international non-governmental organizations. Stimulation of the interest of decisionmakers and the public at large.

(h) Promotion of the participation of developing countries in international programs focused on global environmental problems in which microbes play an important role, such as the safeguarding of the biogeochemical cycles; for such programs, data from developing countries are required. Due recognition is given to the different priorities that developed and developing countries can give to such projects.

(i) Creation of an awareness of the positive and negative impacts that can be anticipated from scientific breakthroughs in microbiology (e.g., enzyme engineering, genetic engineering).

## Methods of the Program

While UNESCO and UNEF provide the program official status, organization expertise, administrative facilities, and basic funding, the ICRO provides scientific guidance -- through a Microbiology Panel whose members are slected for scientific competence and willingness to cooperate actively without remuneration. Rotation ensures both continuity and "rejuvenation", and an increasing number of the panel's members are being drawn from the developing countries. The most important instruments used in the execution of the program are surveys, conferences, training courses, Microbiological Resources Centers (MIRCENs), and coordination activities.

Surveys are conducted to provide an insight into the status of applied microbiology in different geographical regions and also serve to identify persons and organizations capable of serving as focal points for program activities. The Panel now possesses a useful data base for future policies as well as the means to obtain more specific information when required.

Conferences on Global Impacts of Applied Microbiology (GIAM) have an important function in the program. Participants from developed countries (a minority) join their colleagues from the developing countries in discussing a broad spectrum of topics of direct interest to the region in plenary and specialized sessions. Other events range from travelling seminars to training courses; special symposiums dealing in depth with topics of regional significance (e.g., nitrogen fixation, or indigenous fermented foods) often are added to the program. In many cases, microbiologists from a specific region meet one another for the first time during a GIAM conference, promoting future cooperation on relevant regional needs.

About thirty training courses involving over 500 trainees have been held so far in Asia, Africa, and Latin America on subjects involving the major areas of activity. The teaching faculty consists of a few foreign experts who assist in the preparatory work and as many local and regional experts as possible. The study program includes lectures, bench work in the laboratory, evening seminars, and field trips. Additional activities now under consideration are special refresher courses, technician training, and expansion of the existing small fellowship program in conjunction with the MIRCENs.

In 1976-1977 a pilot project was started involving two MIRCENs specializing in nitrogen fixation (Porto Alegre; Nairobi), two

MIRCENs specializing in the collection, preservation, and maintenance of cultures (Bangkok; Cairo), and two auxiliary MIRCENs (Stockholm; Brisbane). These institutes were selected because they were both capable and willing to expand their activities to fulfill an additional regional function with regard to training, research, preservation of cultures of economic importance and, most important, dissemination of cultures and information on how to use them. Some of these MIRCENs have become operational and have engaged in preparing regional catalogues of cultures, directories of institutes, and newsletters. They will become focal points for future training activities of the program.

The Brisbane, Australia MIRCEN comprises the World Data Center on Microbial Genetic Resources, and has special centralized functions, both receiving and disseminating data on all available microbial cultures in the world and assisting in the identification of new isolates. The Stockholm MIRCEN, housed in the Karolinska Institute, provides training support and technical assistance, specializing in the design of simple diagnostic equipment that can be made in the developing countries.

The program has helped promote the formation of regional networks for cooperative research by bringing together scientists who were previously unaware of each other's activities. Numerous personal ties have been forged between scientists from developing and from developed countries, to the benefit of both. The program is expected to make the universities and governments of the developing countries more aware of the importance of applied microbiology which, especially in developing countries, does not receive the priority its potential benefits warrant.

[Extracted with permission from Chapter 18 of Mobilizing Technology for World Development, Edited by Jairam Ramesh and Charles Weiss, Jr. New York; Praeger Publishers for the International Institute for Environment and Development, and the Overseas Development Council, 1979. Copyright© Overseas Development Council, Washington, D.C.]

# New Genetic Technologies: Prospects and Hazards

Jonathan King

[This article describes briefly some of the new possibilities opened up by recent discoveries in biology, notably those enabling scientists to combine genes from different species and "redesign" organisms -- including even human beings. Some of the hazards of these new technologies, and the moral questions they raise, are noted.]

During the past 30 years we have witnessed extraordinary advances in knowledge of fundamental biological processes, particularly at the cellular and molecular level. These advances have derived in large part from the major investment of public funds in the training of biomedical scientists and support for biomedical research, conducted by the governments of the industrialized countries since the end of World War II. In the U.S., these programs originated in the pressing need for coordinated bio-medical research to deal with the immense damage suffered by soldiers during and after World War II. The federal funding and encouragement of cooperative, organized research ventures was highly successful and continued after the war.

The well-financed program of training and research has led to: the elucidation of the chemical structure of the genetic material, DNA; the understanding of the organization of the genetic material in linear segments, the genes; the recognition that genes are blueprints for the structure of protein molecules, which form both the building blocks and working parts of cells; the understanding of the roles of the thin membranes that divide cells into different compartments; and enhanced knowledge of

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the organization and functions of the complex ribosomes, themselves composed of more than 70 different kinds of protein molecules, which serve as the factories for assembling new proteins according to the instructions of the genes. Thus, the work of tens of thousands of laboratory workers have revealed the extraordinary richness and creativity of the mechanisms by which living things reproduce themselves and interact with their environment.

In the industrialized nations, the major steps in cutting infant mortality, increasing the life span, and controlling infectious disease occurred earlier in this century. These resulted from the improved standard of living - notably the shorter working day, increased wages, and improved working conditions - aided by public health professionals who fought for improved sanitation, water supplies, and food, thereby helping to eliminate cholera, diphtheria, scarlet fever, and other scourges of the urban poor. The more recently acquired understanding of the biochemistry of bacteria and the role of viruses in human disease, and the development of tissue culture technology for growing cells and viruses in the test tube, laid the basis for eliminating a further set of diseases: polivirus infections in the 1950s; rinderpest virus, a major killer of African cattle, in the 1960s; and more recently, the dramatic eradication of smallpox. (Twenty years ago in India alone there were 150,000 cases of smallpox, causing 41,000 deaths.) The elimination of rinderpest and smallpox viruses resulted from campaigns organized and coordinated by the United Nations. The scientific basis now exists for mounting research campaigns against viral diseases such as Rift Valley Fever in North Africa, yellow fever in Central Africa, and hemorrhagic fever in Asia, as well as such widespread parasitic diseases as schistosomiasis and filariasis, including one of its more tragic forms, river blindness.

Of course, many of these diseases are intimately associated with particular conditions of life -- housing, water supplies and sanitation, and nutrition. Increased knowledge of the biochemistry and physiology of particular organisms does not substitute for the need to study the interrelationships of organisms within ecosystems as well as the social and economic conditions of human society. Smallpox infects only humans, for example, enabling all potential hosts to be identified and vaccinated. Many of the other viruses that affect humans also live in insects or animals and other parts of the ecosystem. These cannot be eradicated by the same strategies used for smallpox.

Another major contribution of modern molecular genetics and cell biology is the recognition that much of human cancer is due to damage by external agents to the genes of human somatic cells. These agents include industrial chemicals such as aniline dyes, which cause bladder cancer, vinyl chloride, which causes liver cancer, and most forms of ionizing radiation. For example, high levels of leukemia and bone cancer are found among survivors of the Hiroshima and Nagasaki holocausts and among people repeatedly exposed to nuclear testing. Other cancers from excessive medical irradiation and exposure to mismanaged nuclear waste will likely manifest themselves in coming years. These major breakthroughs have led to the recognition among a sector of the scientific community that much human cancer is preventable.

## Recombinant DNA Technology

The growth of biological knowledge has engendered the development of very sophisticated biochemical genetic technologies. These technologies, which are today tools for the accumulation of knowledge of organisms, are also the tools for the genetic and biochemical modification of those organisms. The most dramatic and revolutionary of these technologies is recombinant DNA technology, or genetic engineering -- the ability to incorporate segments of DNA, i.e., genetic material, derived from one organism into the cells of another organism. The donor and recipient may be closely related (for example, two strains of bacteria), or they may be very different (for example, a mouse and a bacterium).

Members of the same species exchange segments of genetic material regularly; this is the biological basis of mating and sex -- the exchange of equivalent segments of genetic material of parents, generating new genetic combinations in the offspring, which may prove advantageous in adapting to a changing environment. However, exchange of genetic material between members of unrelated species is rare. Organisms adapting to different environments -- to different niches, to use the ecologists' term -- evolve different "instructions": different genes. Exchange between such organisms is generally not useful, and therefore rarely observed in nature.

Recombinant DNA technology is useful in biological research, however. Suppose I am studying how pancreatic cells produce insulin and why liver cells do not. I might remove the pancreas from a mouse, and extract from the pancreas cells the long, stringly DNA molecules that represent the blueprints for being a mouse. By treating the isolated DNA molecules with a special protein catalyst, the DNA can be cut into shorter pieces, with the cut ends left sticky. Using similar techniques, I can isolate DNA molecules from a bacterium, whose cut ends are also sticky. Usually this bacterium will be one common in the human gut, and called E. coli. On mixing the two tubes of DNA, the sticky ends of mouse DNA will join with lengths of bacterial DNA. Such molecules, containing the genetic material of two different organisms, are termed "recombinant DNA" molecules. These recombinant molecules can then be reincorporated into a living, growing bacterium. When the bacterium divides, it will reproduce its own DNA, and also reproduce the piece of mouse DNA, or gene. If we isolate the bacterium and incubate it in some beef broth, the next morning we will have 100 billion daughter cells. Each of these will have an identical copy of the mouse gene. Molecular biologists speak of this as "cloning" a mouse gene.

Because bacteria, despite their complexity, are vastly simpler than mouse cells, the techniques of chemistry and biochemistry can be used to study the mouse gene and sometimes the protein whose structure it encodes. From these studies, we might learn about what signals turn this gene on in some cells and off in others. We might also get some hint as to how the genetic information stored in the nucleus of a cell provides the blueprint for the three-dimensional structure and function of the cell. This technology requires no more equipment than is found in a common college microbiology laboratory. Therefore, it is being used in a vast variety of research situations. Furthermore, recently developed techniques make it possible to transfer in the *other* direction to introduce DNA of a bacterium into a mouse cell. Similarly, one can introduce DNA from one species of mouse into another, or transfer small segments of DNA from human cells to mouse cells or other human cells. This technology, developed originally from microbiology and molecular genetics, provides the technological basis for human genetic manipulation. Because of the intense level of research -- hundreds of laboratories are using these techniques to study the genes of animal cells -- experiments labelled "impossible" become routine six months later.

## Commercial Exploitation and Biological Hazards

While the scientific community mainly uses recombinant DNA technology as a research tool, private corporations have moved rapidly to construct and market strains of economically or agriculturally valuable organisms and their byproducts. In addition to the activities of small venture firms and most of the pharmaceutical industry, substantial investments have been made by transnational corporations such as International Nickel, Standard Oil, and Imperial Chemical Industries. A well-publicized case in the drug industry is Eli Lilly Corp.'s plan to grow strains of E. coli bacteria containing insulin for sale to diabetics. Strains have already been constructed or isolated that contain the human insulin gene and that synthesize the protein and export a version of it outside the cell. Lilly believes this will be less expensive than its current practice of extracting insulin from the pancreas of beef cattle. The sale of insulin to diabetics is a $100-million-a-year business.

There has been substantial debate over recombinant DNA technology. The debate has centered on whether bacteria incorporating foreign DNA constitute new hazards to humans or to other species.

For example, though E. coli is a normal inhabitant of our intestinal tract, certain strains are the causes of infantile meningitis and diarrhea, urinary tract infections in women, and serious bloodstream infections in hospital patients. In many cases, the pathogenicity of these strains derives from small parasitic DNA molecules which they carry. These "plasmids" confer special properties on the bacteria such as toxin production, and can also be transmitted from bacterium to bacterium. Derivatives of these plasmids are used as carriers of foreign DNA in recombinant DNA technology. If a plasmid coding for insulin was transmitted from a laboratory strain of E. coli to one of the wild pathological strains it could cause additional damage.

To the extent that such strains of bacteria escape into the environment and establish themselves somewhere, they constitute a form of pollution, an unwanted byproduct of technology. But such biological pollution is qualitatively different from other forms of pollution such as heavy metals, oil, and synthetic chemicals. Organisms reproduce themselves and cannot easily be removed from an ecosystem. This self-reproducing potential of the byproducts of recombinant DNA technology is the reason for the special concern of many scientists and the public.

After considerable internal debate and controversy, the scientific community adopted guidelines requiring that recombinant DNA experiments be performed with weakened strains of bacteria unlikely to survive outside the laboratory, and that physical containment procedures be used, making it even less likely that such strains would escape. These guidelines are now referred to as the NIH (National Institutes of Health) guidelines. A few communities subsequently passed ordinances making the NIH guidelines mandatory. However, they do not apply to private industry or non-federally funded research. During 1979 the guidelines were severely weakened by the efforts of a group of scientists actively engaged in the development of recombinant DNA technology in alliance with commercial interests.

Some observers have found it difficult to understand why scientists should be concerned about community-imposed safety standards on laboratory work. However, safety procedures that are a minor inconvenience on work involving 10 milliliters of cells have a very different impact on the production of 1000 liters at the commercial scale. New technologies often result in human casualties. In the case of recombinant DNA technology, we must insist that such costs be reckoned with from the beginning as part of the production process, and not be passed on to an unwilling or unknowing population.

## Human Genetic Engineering

The new biological technologies make possible the ultimate modification: the "engineering" of human beings. There is a great deal of research with small mammals such as mice and rabbits, both in introducing segments of DNA into their cells and in analyzing the

DNA by taking pieces out of the cells and cloning them in bacteria. For example, attempts are now being made to remove bone marrow cells (which form blood cells) from an animal and insert into those cells the DNA segment coding for hemoglobin. The cell with the added segment can be transplanted back into the animal. This is a model for gene therapy of inherited blood diseases such as sickle cell anemia and thalassemia. The use of such genetic technologies on human beings will expand in the medical sector far more rapidly than anyone can accurately predict. This will alleviate the suffering of a number of individuals, but will also generate some moral and social dilemmas.

The development of human fertilization in the laboratory by Edwards and Steptoe has vastly increased the potential for human genetic manipulation. One can obtain in the test tube the earliest stages of a human embryo. By introducing DNA, or cells altered in the laboratory, into this embryo and then reimplanting the embryo into the womb, the possibility exists for introducing genetic change in most of the cells of the body -- including the germ-line cells. Thus, changes would be passed on to subsequent generations.

Prior to the genetic manipulation itself, the use of DNA technology to physically analyze the DNA of human cells will vastly increase. Some of this analysis will be used for screening purposes, as in rare cases where the change in the DNA and the relationship to disease is known (in certain rare inherited blood diseases, for example). Instead of examining the blood in the already mature fetus, we will examine the DNA of the cells of the early embryo or the parents.

Researchers will be confronted by the full range of genetic variation among individuals. What constitutes a genetic defect and what constitutes genetic variation? Historically, the value of many genetically determined features such as skin color and hair character were socially determined. What is a defect in one society can be a desirable characteristic in another. At the biological level, the sickle cell trait is considered by some a genetic defect in the United States. But in central Africa it is necessary for survival in malaria-infested areas, rendering the blood cells resistant to the malarial parasite.

## Reordering Priorities

We must support every effort to expand and increase knowledge of the functioning of living things and their interactions with the environment, and of the effect of human society on these interactions. This knowledge must be available to all the peoples of the earth and not just a technocratic elite. At present, a number of the most potent biological technologies are being developed by transnational corporations and research institutions. To select what is needed in a particular area will require very broad biological, ecological, and agricultural education.

In the area of human experimentation and genetic manipulation, we must ensure that the development of very sophisticated technologies for helping a small number of individuals does not obscure the pressing need for eliminating widespread causes of disease and genetic damage. An appropriate form might be task forces on protection of the genetic inheritance from environmental and social damage. This will entail input into the setting of priorities in biomedical research (i.e., what technologies to develop) and not just into the use of technology that is *already* developed. Today we can transplant kidneys, but we cannot prevent kidney disease.

Public health, social ethics, and the problems of underdeveloped rural societies are not the highest priority of experts in molecular genetics and antibiotic production. We must insure the fullest participation of different sectors of society in the development of biological technologies because this is the only way to maximize the social benefits and minimize the risks. We are entering a new era of direct modification and design of organisms. These endeavors will require new social forms and the development of a much higher level of democratic process within the technological sphere.

[Extracted from Technology Review, Vol. 82, No. 4, February 1980, pp. 64-65. Copyright © by the Alumni Association of the Massachusetts Institute of Technology, Cambridge, Mass.]

# BOOK REVIEW

NORTH-SOUTH: A PROGRAM FOR SURVIVAL - The Brandt Commission Report. Published by the MIT Press, Cambridge, Mass. 1980 (304 pp. $4.95, in paperback).

Reviewed by Anthony Pearce-Batten
Associate Editor, Development Digest

Early in 1977, World Bank President Robert McNamara suggested in a speech in Boston that an independent Commission be established under the leadership of former West German Chancellor Willy Brandt to study issues and problems of development. In September 1977, Brandt announced the formation of the Independent Commission on International Development Issues. Its task was "to study the grave global issues arising from the economic and social disparities of the world community, and to suggest ways of promoting adequate solutions to the problems involved in development and in attacking absolute poverty". In February 1980, the Commission released its final report, entitled North-South: A program for Survival, after eight meetings held at locations all over the world. The Report represents a consensus view of the Commission's eighteen political and opinion leaders, ten from the developing countries, and eight from the industrialized nations, all of whom served in a private capacity (listed below - p. 128).

Citing increasing dangers to world security, the Report of the Independent Commission on International Development Issues, the so-called Brandt Commission, warns that in the efforts to reduce tensions and resolve the world's economic problems, one major source of instability has been overlooked: the gap between rich countries of the "North" (North America, Europe, USSR, Japan, Australasia) and poor ones of the "South" (Latin America, Africa, the rest of Asia). "The dialogue between North and South will not by itself solve all the world's current problems, but we are satisfied that the world community can have no real stability until it faces up to this basic challenge", the Commissioners conclude. Noting their very different perspectives, "we have all come to agree that fundamental changes are essential, whether in trade, finance, energy, or other fields, if we are to avoid a serious breakdown of the world economy in the decades of the eighties and the nineties, and to give it instead a new stimulus to function in the interest of all the world's people" (p. 31).

In a comprehensive analysis of the economic linkages between industrialized and developing countries, the Commission argues that the mutual gains to be realized should act as a powerful incentive to the industrialized North to adopt its recommended measures to encourage faster growth and development in the South. Development is generally equated with economic growth; industrial and agricultural progress appear to be of equal importance.

The mutual gains among nations constitute a necessary condition for adoption of many policy measures the Report advocates, but these are not an "adequate" incentive for acceptance of all its proposals. "Especially as far as the poorest people and the poorest countries are concerned,the principal motives of our proposals are human solidarity and a commitment to international social justice... It cannot be accepted that in one part of the world most people live relatively comfortably, while in another they struggle for sheer survival. As we shall argue, there are material reasons for trying to end this state of affairs--international political stability, expanding export markets, the preservation of the biological environment, the limitation of population growth. But we speak of solidarity as something that goes beyond mutual interests" (p.64).

Both North and South must begin working toward a "rational and equitable international economic order" the Report states, which will permit the full participation of all countries and self-sustaining growth by the developing nations.

## The World According to the Brandt Commission

The Report presents a view of the world which summons the developing countries from deep within the wings onto center stage. In its emphasis on both mutual gains and shared dangers, the Report elevates the art of "interdependence analysis" to new heights. Indeed the combined threats of hunger, poverty, resource constraints and environmental degradation to global security have the effect of expanding the list of mutual gains far beyond the trade, commodity and other economic advantages which are usually cited. In this way the Brandt Commission forges links between its explicit objectives - to encourage faster economic growth and the expansion of world trade - and the wider task of overcoming the worst aspects of poverty by the end of the century. The economic benefits, in terms of increased efficiency plus the mutual losses averted, outweigh the substantial costs in additional aid which such an undertaking will require, in the Brandt Commission's view. The Report goes further and argues that "there are interdependencies not only between countries but between issues". The Commission's exhaustive list of recommendations is based on its identification of the "numerous interconnections" between the various priorities on the global agenda.

## Interdependence Among Countries

One country's economic growth is increasingly dependent upon the economic performance of other countries, the Commission observes almost at the outset of the Report, and this linkage pertains with as much validity to economic relations between developed and developing countries as it does to relations within each group. "The South cannot grow adequately without the North", the Commission states. "The North cannot prosper or improve its situation unless there is greater progress in the South". Evidence of this economic linkage is the role of the developing countries in cushioning the blow of the 1973-75 recession on the industrialized countries by continuing to buy Northern products with borrowed funds. The Report cites an OECD study relating the effect of continuing Southern demand to some 900,000 jobs in the industrialized countries annually between 1973 and 1977.

Effects such as these serve as the rationale underlying the Report's call for sharp increases in the flow of resource transfers to the developing countries. Such transfers would serve to encourage growth at a time when the industrialized countries are experiencing substantial under-utilization of capacity, and to stimulate trade and, therefore, the most productive industries in developed and developing nation alike. How much growth? Quoting the OECD again, the Report cites annual increases of 3 per cent in OECD exports to the developing countries over three years as a consequence of $20 billion in increased aid flows in each of those years. Such flows are all the more necessary in view of the possibility that private sources of finance will dry up as the payments deficits of the developing countries increase with rising oil prices. Between 1973 and 1978 debt grew 2.5 times as fast as exports for more than half the oil-importing developing countries, the Report observes, putting pressure on many major banks to restrain lending to them. Without corresponding increases in official bilateral and multilateral lending, such a reduction in the flow of private funds to the Third World would slow economic growth.

Not surprisingly, The Report deems the current trend toward protectionism in the industrialized nations "one of the great enemies of recovery". Citing a large Northern surplus in the trade of manufactured goods, the Report warns: "In the end, the failure of the mature industrial economies to adjust to the realities of international competitiveness may deprive them of their prosperity and impose far costlier and more disruptive adjustments than those which their current measures of protection attempt to postpone". Apart from clothing and textiles, the negative employment impact on the OECD countries of their imports of Third World manufactures has been small, the Report observes, citing several studies to that effect, while offering important anti-inflationary benefits. At the same time, the possibility of further trade restrictions discourages new investment in the developing countries.

One area thought to be in need of adjustment is raw materials, where the Commission supports price and earnings stabilization, and the location of more processing industries in the commodity-exporting countries. Among the price stabilization measures which the Commission supports are the Common Fund, and International Commodity Agreements. Compensatory financing should play a larger role in stabilizing earnings. The removal of Northern tariff structures which discourage the importation of products in manufactured form as opposed to primary commodities would serve to increase Southern export revenues which could be used for other developmental needs.

The Report makes several recommendations to intensify the search for oil in the developing countries, as well as the search for non-oil alternatives, and these too are clearly in the interest of North and South alike. Other areas of mutual gain include environmental conservation, and efforts to increase agricultural productivity in the developing countries.

"A very substantial mutual interest lies in harnessing the economic strength and experience of the multinationals for development", the Brandt Commission observes, provided that the costs and disadvantages to the South of the multinational corporations' activities can be "regulated". Such organizations can provide the capital and the expertise to assist in development of minerals and other resources, including fuel exploration and development.

"We do not suggest that the measures we propose are without cost to the North", the Brandt Commission states. "The North must share its resources and its control of institutions; it must be willing to work for some changes in the way markets operate, which is presently to its advantage. But we do suggest that the North as well as the South gets much in return, both in straightforward economic benefits, and in a reduction of uncertainties and instability".

## Issue Interdependence

The Report seeks to present a picture of the world which goes beyond a "piecemeal treatment" of North-South issues, in the words of the Commissioners. They conclude their chapter on mutual interests by urging acceptance of their recommendations, not merely because of their intrinsic value but because "they contribute importantly to each other.....Mineral problems, for example, cannot be fully resolved without action on the financial front, on the issues affecting the multinationals, and in the field of commodity agreements. The energy question requires action in these areas, and also a broader framework of international agreement. Debt, the international banking system, commodities, and access to markets for manufactures are closely interrelated".

The Brandt Commission identifies similar linkages between its growth and welfare objectives, and by so doing articulates a perspective in which welfare measures contribute to the long-run efficiency of the international economy.

The Commission's treatment of the poorest countries is a case in point. Growth and welfare means and objectives are closely interrelated. On the one hand the long run objective underlying the Report's proposals is to extend the web of trade and financial links to include the poorest countries upon their attainment of the threshold of self-sustaining growth. Such an objective will require sharply increased flows of concessional assistance. A second goal is to eliminate the worst aspects of world poverty by the end of the century. "We emphasize that human needs can only be met by the productive efforts of the society which strives to meet those needs," notes Willy Brandt in his introduction. "The only way to make this possible for developing countries, particularly the poorest ones, is for them to build up and develop their own productive capability".

The Report identifies agriculture as the poorest countries' top priority. To avert a 20 million ton food shortfall by 1990--a third of consumption in those countries--water control and crop management are considered the top priority for attaining improvements within agriculture. Other measures include the provision of basic health services, and the elimination of such diseases as river blindness, sleeping sickness and bilharzia which pose a barrier to the cultivation of large arable areas. Intensive afforestation efforts (as appropriate), greater mineral exploration and development, and more regional cooperation are also features of the Commission's recommended aid program for the poorest countries.

The combined food shortfall for all the developing countries as reflected in net imports, which are projected to increase from 80 million to 145 million tons between 1978-9 and 1990, makes increased agricultural output a major priority the Third World over, the Commission observes, stressing a theme often heard in development cicles. What is different about the Brandt Commission's assessment is its emphasis on non-agricultural progress as part of the solution to the Third World food problem. "Not only must the food be there", the Report notes, but "people who need it must be able to buy it". Internal measures to improve output, including agrarian reform where necessary, need to be supported by increases in external assistance--estimates vary between $4 billion and $8.5 billion annually in addition to the existing $3 billion a year--throughout the 1980s. Internanational food security should be guaranteed by establishing the International Grains Arrangement, with larger emergency food reserves and a food financing facility. Food aid remains important, the Commission observes, when it does not weaken production incentives. Added support for international agricultural research institutions is a further necessity, the Report notes.

But part of the effort to promote agricultural development should be to generate income in whatever may be the most productive sectors of developing countries, the Report argues. "Neither food aid nor an emphasis on agricultural development will succeed in the conquest of hunger". The growth of employment in non-agricultural productive activities is necessary to increase the effective (monetary) demand for food. Export-oriented industrial development is necessary to provide foreign exchange for the importation of farm equipment and fertilizer. The availability of purchasable consumer goods provides additional production incentives for farmers. The potential for rapid growth is much greater in the manufacturing than in the agricultural sector. "So the problem of hunger connects clearly with the rest of the Report", the Commissioners conclude. "The expansion of trade and finance, including co-operation among developing countries, which can permit incomes to rise is as important as producing more food or distributing incomes. The low-income countries need assistance both for rural development and for raising the entire productive capacity of their economies which alone can create adequate income and jobs. There are no shortcuts to eliminating hunger".

A similar linkage ties success in stemming the growth in population to development. "What is done to meet the challenges of poverty, ill-health and hunger is a primary contribution to checking excessive population growth", the Commission notes. "In the final analysis, it is development itself that will provide the most propitious environment for stabilizing the world's population at tolerable levels. In the creation of that environment, all countries have a mutual interest. The prospect of an overcrowded planet in the next century has little meaning to people who live on the margin of existence today".

## The Task of the Developing Countries

"No examination of international development issues can be realistic without a full appreciation of the essential tasks which developing countries must themselves undertake in pursuit of real development", the Report observes. Such obligations, which should not be regarded as conditional on Northern concessions on international economic reforms, include social and economic programs to redistribute incomes and resources and reduce poverty within countries, provision of social services, with more economic cooperation between developing countries. These countries are also responsible for achieving increases in agricultural support. The efficient administration of aid funds and improved planning are also cited.

An additional responsibility of the developing countries is, in the Brandt Commission's view, to contribute to a more stable investment climate. The report advocates fair compensation for nationalization, and increased U.N. technical assistance to the poorest countries in negotiating investment agreements with multinational companies.

## Other Proposals

Transnational Corporations and technology transfer would be subjected to effective national laws and to an international code of conduct. Both host and home countries would have reciprocal arrangements covering foreign investment, technology transfer, and repatriation of the proceeds. The Report urges intergovernmental cooperation in such matters as taxes and transfer pricing. The poorer countries should receive technical assistance in negotiating agreements with transnational corporations. All countries would retain permanent sovereignty over their natural resources.

The Report proposes several international monetary reforms. The Report supports creation of an IMF "substitution account" to replace national currencies with SDRs (Special Drawing Rights) as the primary reserve currency. New SDRs would be created to increase world liquidity but in a noninflationary way; the distribution of new SDRs should favor those developing countries with adjustment problems.

The Report also endorses a new approach to development finance, along with action on several older approaches. For example, it urges adoption of the UN aid target of 0.7 per cent of GNP by the industrialized countries, rising to one per cent by the century's end. New ideas include "an international system of universal revenue mobilization, based on a sliding scale of national income from which only the poorest countries would be exempted; taxes on international trade and weaponry; and exploitation of the "global commons, especially seabed minerals" These new revenue sources would contribute to development funds; the report does not explore how such taxes would be imposed and collected.

This new approach also incorporates several major reforms in the way that the international financial institutions do business.

The World Bank should double its gearing ratio (the ratio of its permitted borrowing to its capital) from 1:1 to 2:1, raising its borrowing capacity from $80 billion to $160 billion. More development funds should be channelled through the Regional Development Banks. The remaining portion of the IMF's gold should be used as collateral in increasing the flow of development finance to middle income countries, or sold to provide an interest subsidy to the poorer countries. The Report urges more responsiveness by the IMF and World Bank to the problems faced by the developing countries, and more Third World influence over their day to day operations. To fill some of the existing gaps in development finance, particularly the developing countries' program lending needs, the Report urges the establishment of a new institution. This World Development Fund would distribute the new revenues raised from the levies proposed by the Report, would stress program lending, and would have its decision making "shared evenly" by borrowers and lenders.

Other features of the Report's development finance proposals include more finance for mineral exploration and development, increasing maturities on multilateral debt, and assistance in placing bonds of developing countries in international markets through a collective guarantee system.

## An Emergency Program

In the Brandt Commission's view, the world cannot wait for its various suggested policy measures to be widely adopted and to take effect, and the Report proposes an emergency program with the following features in response to the most pressing needs.

> Resource Transfers which would include an increase of concessional aid to the poorest countries of $4 billion annually, and increased non-concessional lending to the middle income countries.
>
> Energy - an accord between energy producers and consumers assuring security of supplies, more conservation, and efforts to reduce the economic impact of price increases. The industrialized nations would commit themselves to more ambitious conservation targets and, together with oil producers, would agree on their respective roles in recycling OPEC surpluses to the developing countries.
>
> Food production assistance would increase by some $8 billion annually (including part of the $4 billion to the poorest countries). The Report urges an early

conclusion to the International Grains Arrangement, and increases in emergency food supplies.

International Economic Reforms include adoption of many of the Report's development financing proposals, including estblishment of the World Development Fund and use of IMF gold. Other measures urged by the Report include trade liberalization, and more efforts to increase food production and to reduce income inequities by the developing countries themselves.

As a first step toward implementation of these proposals, the Report calls for a summit conference of world leaders.

## An Assessment

Perhaps the most striking feature of the Brandt Commission's Report, apart from its comprehensive treatment of development issues, is its warning that resolution of North-South differences and issues is a precondition for defusing the dangerous period in which the international system finds itself. The effect is to project the needs of the developing countries into the center of the action, from their usual position in the chorus of voices vying for the attention of policy makers in the industrialized nations. The Report's identification of the shared interests between North and South amounts to a major extension of the mutual gains thesis.

It is simplistic of course to infer that the Commission's vision of the world could only proceed from the mind of a person of Willy Brandt's stature, one who earned distinction by looking in a new way from West eastward to the Soviet Union, as he now shifts in perspective from North to South. This would do a great disservice to the energies and efforts of the Commission's other distinguished members. Yet such a view pervades the Report's analysis, and reorders in a new configuration the various more or less well-known events that collectively amount to the North-South dialogue. While there is little that is new in the Report in terms of the evidence and data it cites in support of its various contentions, many of its policy prescriptions and the sweep of its world view are bold and imaginative, and somehow characteristic of Willy Brandt. And the clarity of the Commission's perspective on world issues contrasts with the vaguely worded concepts which enshroud most such international and Committee-written documents.

To be sure, the Report has its shortcomings. Left entirely to themselves, goes one of the initial premises of the Report, economic forces tend to produce growing inequality between and within nations. This premise is not restated elsewhere in the Report nor developed further, and in any case is open to question. The remarkable performance of several developing countries in closing the international development gap, while also establishing greater internal economic equality, countries whose economies are characterized either by lack of government intervention or by a form of intervention designed to accentuate growth rather than increase welfare, casts doubt on this assertion. Within countries, it is arguable that interventionism has contributed to growing inequalities.

Several of the Report's shortcomings relate to its perceptions of mutual gain, just as many of its strengths do. The issue of commodity price stabilization and the benefits it offers the industrialized nations is a thorny one and the Report tends to gloss over the major difficulties. One of the major obstacles, for example, in negotiating commodity agreements has been price. The Report's answer? It should be "remunerative". Another example would be the proposed international tax on arms transfers, which presupposes among other things an improbable degree of openness in arms transactions. In addition, the Report has a propensity to advocate a wider role for international agencies without indicating, in some cases, how this would be beneficial - in contrast with deprecatory remarks elsewhere in the Report about the proliferation of international meetings and organizations.

Perhaps the main comment that can be made on this bold and sweeping approach to the world's problems is not so much that it is careless with details (it would be hard not to ignore many of these in such a globalistic undertaking), as that it assumes a level of international will to accept its objectives that is equally sweeping. National self-interest is a powerful common denominator among countries. So many of the Report's objectives - high aid levels, agreement on international food reserves, monetary reform, etc. - have been put forward and encountered obstacles stemming from national interests that these cannot be forgotten in any realistic assessment. But perhaps the world is in need of a prophetic vision that can rise above short term realism.

List of Members of the Independent Commission on International Development Issues

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1980—310-928/3

In Africa, Asia, and Latin America, the DIGEST is distributed through the U.S. Agency for International Development to persons with a professional concern with the development process. Requests for copies should be directed to the AID mission or, if there is no AID office, to the U.S. Embassy.

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# DEVELOPMENT DIGEST

S18.33:

The DEVELOPMENT DIGEST is prepared for the Agency for International Development by the National Planning Association, a private, non-profit organization in Washington, D.C.

We would appreciate comments of an editorial nature and suggestions of material for possible inclusion in the DIGEST. Please address:

Editor: DEVELOPMENT DIGEST
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1606 New Hampshire Avenue, N.W.
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Use of funds for printing this publication approved by the Director of the Bureau of the Budget June 2, 1966.

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# DEVELOPMENT
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A quarterly journal of excerpts, summaries, and reprints
of current materials on economic and social development

Gordon Donald, Editor; Anthony Pearce-Batten, Associate Editor;
Lowell Shaffer, Digest Secretary
Prepared by the National Planning Association

for

Agency for International Development, U.S. Department of State

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Volume XVIII - Number 4 October 1980

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# URBAN-RURAL INTERFACE

TWO SCENES FROM COLOMBIA, ONE
OF DOWNTOWN BOGOTA AND ONE
FROM A VILLAGE.

# Development Activities and Rural-Urban Migration

Richard E. Rhoda

[This study asks: Is it possible to "keep them down on the farm" by means of rural development activities? Most development activities have a mixture of features that make rural life more attractive or profitable, and others that are conducive to urban migration, with the latter probably more important in the long run.]

Increasing urbanization is one of the most pervasive processes in developing countries. According to a recent World Bank document, "Between 1975 and the year 2000 the cities of the developing countries will be expected to absorb 70 percent of the projected population increases--1.3 billion." Such projections give the impression of massive rural-urban migration flows and extreme problems of urban poverty and unemployment. Governments are particularly concerned; they often assume that the problems of urban poverty are a direct consequence of rapid urban growth. A recent survey of governments in 98 developing countries indicated that half considered present levels of metropolitan growth excessive. The governments tended to link urban poverty problems with rural-urban migration; about three-quarters of the surveyed countries were pursuing programs designed to reduce migration flows.

A relatively popular belief is that improvement of conditions in rural areas will reduce rural-urban migration and consequently relieve some of the growing problems of poverty in urban areas. Many rural development activities have been justified partly on the grounds that they will reduce urban migration. The proposition that development activities in rural areas will reduce rural-urban migration seems intuitively

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obvious: development will make rural areas more attractive, therefore, people will be less apt to leave. Development will increase rural incomes and employment, thus diminishing the major motivation for migration--namely, economic gain. At first glance the proposition appears to be consistent with both migration theory and empirical studies of rural-urban migration. On closer inspection, however, some of the migration and development literature suggests that development activities in rural areas may even increase rural-urban migration. The proposition which seems so intuitively obvious at first is actually a hypothesis in need of testing.

Thorough reviews of the migration and development literature indicate that little research has focused directly on this hypothesis for several reasons. First, the hypothesis seems so obvious that it may not have appeared worthy of investigation. Second, the separation of academic research and applied knowledge may have contributed to the neglect of this issue. Anthropologists working in rural areas could provide considerable information concerning the hypothesis, but they have generally selected culturally "pure" areas which were not contaminated by development activities. Other social scientists studying rural societies have tended to concentrate more on those who remained rather than those who migrated. On the other hand, there have been a great number of studies on rural outmigration, but unfortunately few of these focused on the relations between migration and development activities. Third, development agencies have seldom allocated resources for the evaluation of such social impacts of their projects as rural-urban migration. Lack of research on the hypothesis may also stem from the general absence of effective methodology for conducting social impact analyses.

The logic behind the belief that development activities in rural areas will reduce urban migration and therefore alleviate urban poverty is based upon some or all of the following propositions. 1) Migration is the primary cause of urban population growth and rapid increases in urban poverty. 2) The majority of those in urban slums and squatter settlements are migrants. 3) Most migrants are poor, or not as well-off as urban natives. 4) The flow of migrants into urban areas primarily originates in rural areas. 5) Migrants who are forced to leave rural areas due to rural poverty and unemployment usually move into urban areas. 6) Improvement of conditions in rural areas will reduce the flow of rural-urban migration. 7) Development activities in rural areas will improve rural conditions and therefore reduce rural-urban migration. Unfortunately, this set of propositions is not completely consistent with empirical evidence.

Empirical studies indicate that migration is not the main cause of urban population growth. Available data suggest that natural increase (the difference between births and deaths within urban areas) accounts for almost 60 percent of the increase in urban populations. Another factor is natural increase in rural communities which pushes their population across arbitrary urban-rural classification borderlines, thus causing them to be reclassified as "urban." The city limits of urban areas are often expanded to encompass populations which were previously classified as "rural." Recent calculations based on United Nations data indicate that during the next decade rural-urban migration will account for somewhat less than 25 percent of the urban population growth in Latin America and less than 40 percent in Africa and developing countries of Asia.

Many recent studies have focused on migrants in slums and squatter settlements. These studies give many readers the impression that most of the residents of slums and squatter settlements are migrants, and that most migrants are poor. Reviews of available information, however, suggest that migrants are generally almost as well-off as urban natives. Though many migrants arrive relatively poor, a very sizeable proportion are quite successful; in fact, the socioeconomic distributions of migrants and nonmigrants tend to be quite similar. Empirical evidence suggests that migrants usually are a minority in urban slums and squatter settlements, even though such areas may have a higher percentage of migrants than the total city.

Another popular misconception concerns the origins and destinations of major migration flows. Many appear to assume that migrants in urban areas have come from rural areas, and that those who leave rural areas migrate to urban areas. Available evidence indicates that a very sizeable proportion of migrants to urban areas come from other urban areas, especially in highly urbanized Latin America. For example, less than 15% of migrants to Santiago and less than 25% of migrants to Bogota came from rural areas. Rural to rural migration is also important, particularly in the less urbanized areas of Africa and Asia. A well known example of rural to rural migration is the movement of rural labor into the cocoa and coffee producing areas of West Africa. Indeed, urban-to-rural migration is also significant in many areas. A study of migration in the highly urbanized country of Colombia indicates that over one-third of all migrants had moved to rural areas. In sum, the belief that development activities in rural areas will reduce urban migration and relieve urban poverty is based on propositions that need to be questioned in each case.

The overall purpose of this study is to investigate whether development activities in rural areas reduce or increase rural-urban migration. In this study, rural development activities are defined as actions by national or international agencies designed to increase production or improve quality of life in rural areas. Rural-urban migration is defined as residential relocation from a predominantly agricultural area to one in which a majority of employment is non-agricultural. This does not distinguish between urban centers of different sizes, i.e. market towns and metropolitan areas, but an attempt is made throughout the paper to keep this difference in mind where pertinent. This study is based on analysis of the available published and unpublished literature which is relevant. Two major bodies of literature are screened: the migration literature, and the development literature pertaining to rural areas. It was recognized at the outset that a conclusive answer was unlikely because conditions vary so greatly between countries and between types of development activities.

## A General Social Theory of Migration

Numerous theoretical models of migration have been developed. Those relevant to the purpose of this study can be grouped into social models and economic models. The different social models which are relevant can be incorporated into one general social theory of migration.

Perhaps the first attempt to develop a theory of migration was Ravenstein's presentation of "laws" of migration in the late nineteenth century, generalizations which largely have withstood the test of time. Working from the so-called "laws" and additional empirical generalizations, Everett S. Lee presented his theory of migration in 1966. He attempted to develop a truly general theory which explained internal and international migration in and between both developed and developing areas over a long period of history. Lee's conceptual framework is sufficiently broad to incorporate other social models relevant to our central hypothesis. The framework focuses on migration decision-making and presents four general factors which influence migration decisions: origin factors, destination factors, intervening obstacles, and personal factors.

Origin factors. There are factors which influence migration from the area where migrants originate. Some of the attractive factors tend to hold people in the area or "pull" in others, while unattractive factors may be thought of as "push" forces. Factors may influence the migration decisions of different people in different ways. For example, land reform may be perceived as a positive factor by tenant farmers, and decrease their propensity for migration; but land reform can increase the migration propensity of the larger landholders. Generally speaking, development activities in rural areas designed to increase production and improve the quality of life in rural areas should increase the attractiveness of rural areas and, consequently, reduce the propensity for out-migration of most rural people.

Destination factors. As with origins, destinations have attractive and repulsive forces which influence migration decisions: the so-called "pull" of urban areas often is discussed in conjunction with "push" forces in rural areas. However, it should be remembered that both origins and potential destinations contain "push" and "pull" factors. Another important point is that migration is not influenced directly by origin and destination characteristics, rather by the perceptions of these characteristics by migration decision-makers. While origin factors may be accurately perceived, this is not always the case for destination factors. Inaccurate perceptions of potential destinations, often based on lack of information, impose an element of risk for those who migrate.

Development activities that increase production levels in rural areas often lead to a shift from subsistence to commercial agriculture. With increased production, income, and commercialization, the rural demand for urban-produced consumer goods and for agricultural inputs tends to rise. Such increases in demand can generate additional economic activity and employment in urban areas, and this can act as a stimulus to rural-urban migration. In short, successful development in rural areas can increase the "pull" of urban areas and thus contribute to more rural-urban migration.

Intervening obstacles. The simple summation of the push and pull factors at origins and potential destinations does not in itself dictate migration decisions. Consideration must be given also to degrees of natural inertia, and to obstacles between origins and potential destinations. Distance is the most obvious obstacle; countless studies reveal the negative relationship between distance and migration. Both physical distance and socio-cultural distance are important. Physical distance affects the time and cost of initial moves, as well as visits to urban areas. Socio-cultural distance includes differences between origins and destinations with respect to language, degree of modernity, religion, values, and attitudes. Lack of information concerning opportunities and characteristics of potential destinations is related to socio-cultural distance. Physical barriers and enforced migration restrictions may also act as intervening obstacles to migration.

In general, development activities in rural areas tend to reduce intervening obstacles to rural-urban migration. Road and highway improvements, building of bridges, and improvements in transportation services facilitate movement. Development which increases rural incomes enables people to overcome obstacles to rural-urban migration more easily; often people do not migrate because they simply cannot afford it. Perhaps the impact that development has on the socio-cultural distances between rural and urban areas is more important than a reduction in physical distance. The most obvious example is the development of formal education in rural areas which enables rural youth to acquire "modern" urban attitudes, aspirations, language skills, and accreditation in the form of school diplomas and certificates. Thus, formal education has reduced socio-cultural distance greatly and, therefore, resulted in considerable rural-urban migration. Development activities usually involve a shift from traditional systems to modern systems--for example, from subsistence to commercial agriculture, from fatalism to rational planning, from traditional to modern languages and belief systems, and from provincial to urbane interests and attitudes. These changes all tend to reduce socio-cultural distance between rural and urban areas. In summary, a direct impact of development activities in rural areas is the reduction of intervening obstacles to rural-urban migration, which is expected to increase migration.

Personal factors. Personal factors are important because, as mentioned earlier, it is the perceptions of origin and destination factors and intervening obstacles which are crucial to migration decisions. Perceptions of a factor can vary considerably from individual to individual, and different individuals are affected differently by the same factors. Generalizations can be made about types or classes of migration decision-makers (while most theories implicitly assume that migration decisions are made by potential migrants, evidence from developing countries suggests that family heads often make migration decisions for members of their clan).

Development activities in rural areas may have considerable effect on personal characteristics. Increases in individual landholdings are expected to reduce rural-urban migration. Growth of individual income can have either a positive or negative impact on migration depending on the specific situation. Factors which can result in greater propensity for migration include increased levels of education, aspiration, awareness of urban opportunities, and general level of modernization. It appears that the net impact of development activities on personal factors tends to increase propensities for rural-urban migration. However, these impacts are likely to vary considerably from place to place and from individual to individual.

Hypotheses. Lee hypothesized that a number of general propositions can be made which characterize migration in a wide variety of circumstances. He suggested that development activities which accelerate socio-economic change and stimulate progress are expected to increase the volume and rate of all types of migration, including rural-urban migration. Lee also presented hypotheses on the selectivity of migration. He suggested that migrants responding primarily to pull factors at urban destinations tend to be positively selected i.e., to come from more well-off groups in rural areas. On the other hand, those who primarily respond to push factors at rural origins are likely to be negatively selected. Taking all migrants together, selectivity tends to be bimodal--i.e., migrants are more apt to be either relatively poor or relatively well-off. The pattern of bimodal selectivity suggests that development activities which increase equity in rural areas may on balance reduce migration. Lee hypothesizes that the degree of positive selection increases with the difficulty of intervening obstacles: thus, more well-off rural groups are more likely to make the difficult moves, either to distant metropolitan areas or during the early stages of urbanization when socio-cultural distances are great. Development activities which reduce intervening obstacles can lead to less selective migration, as poor rural residents find it easier to move to cities.

Conclusions. Though social theory of migration suggests that development activities in rural areas have both positive and negative impacts on rural-urban migration, the net impact is expected to be positive. The theory suggests one basic reason why development activities may reduce migration: successful development activities make rural areas more attractive in terms of economic activities and amenities; therefore, the desire of rural residents to migrate should be reduced. In contrast, three basic components of social theory of migration imply that development activities in rural areas will increase rural-urban migration. First, development activities result in greater rural-urban integration and the reduction of physical and, more importantly, socio-culture distance between rural and urban areas. Second, development activities are associated with a general modernization of the personal characteristics of rural populations, which tends to increase propensities for rural-urban migration. Third, the theory indicates that as societies progress or develop, migration volumes and rates increase.

## Economic Models of Migration

Three economic models of migration are of particular interest concerning the question of the impacts on rural-urban migration of development activities in rural areas: (1) the individual benefit/cost approach, (2) the expected income model, and (3) the intersectoral linkage model. The well-known labor mobility models of Sir W. Arthur Lewis and Fei and Ranis are not relevant here because their assumption of a stagnant rural subsistence sector excludes the possibility of development in rural areas.

The Benefit/Cost Model. This model uses the concept of investment in human capital to focus on the costs and benefits of migration decisions. The model as developed by Sjaastad assumes that people will migrate when the benefits outweight the costs. Benefits of migration are the present value of potential income gains from the difference in income between origins and destinations. Nonmonetary benefits such as those arising from location preference are also included in the model. Costs of migration include moving expenses, opportunity costs of foregone earnings between jobs, and nonmonetary "psychic costs" such as the disutility of leaving one's home community and settling in an unfamiliar environment. The benefit/cost model is attractive because it recognizes the effect of the individual characteristics of potential migrants. Older people are less likely to move because differential income returns from migration accrue over a shorter remaining lifespan, and "psychic costs" may be greater. Educated youth tend to be more mobile because their origin-destination income differences are usually larger, and their greater awareness probably reduces the "psychic costs" of migration.

The model has a number of implications for the impact of development activities in rural areas. Development tends to reduce migration costs, and may either increase or decrease the benefits of migration. Development in rural areas reduces both the money costs of migration by improving transport and. more importantly, non-monetary or "psychic costs." Development in rural areas can increase the benefits of migration by preparing rural residents to more effectively participate in urban activities. Development is associated with improved occupational skills, higher levels of education, greater aspirations, and more modern attitudes; such changes enable rural residents to better exploit urban economic opportunities. Modernization of rural residents may also act to increase the nonmonetary benefits of migration --i.e., the appreciation of urban amenities, social opportunities, entertainment, etc. On the other hand, development activities also increase the benefits of not migrating. Development can increase rural income and employment as well as provide improved living conditions; such changes make rural areas more attractive places to live. In short, rural development activities tend to increase both the benefits of migration and those of nonmigration; the crucial question is whether or not it increases or decreases net benefits of migration. If development activities have equal impacts on the benefits of both migration and nonmigration, i.e., if there is no net change in benefits, then rural-urban migration should increase because the costs of migration are reduced.

Expected Income Model. This model was developed by Todaro in an attempt to explain a seemingly paradoxical situation of continued rural-urban migration in the face of rising unemployment in cities. The model is based on the idea that migration decisions depend upon perceptions of "expected" income. Expected income in rural areas is based on prevailing rural incomes and wages; in urban areas, expected income is a product of the (often high) urban sector minimum wages multiplied by the probability of gaining urban employment. According to the model, rural-urban migration will continue until this expected urban income is equal to the expected (prevailing) rural income. The model has received considerable attention and refinement.

The model focuses attention on the selection of appropriate employment policies in urban areas, and it also has implications for development activities in rural areas. Todaro indicates that investment in rural amenities and efforts to reduce rural-urban income differentials will result in decreased rural-urban migration. Harris and Todaro point out that, while creation of urban jobs will reduce rural production through induced migration, job creation in rural areas will not reduce industrial output and, in theory, will induce urban-to-rural return migration. Thus, the expected income model implies that development activities in rural areas will reduce rural-urban migration flows. This model, and the economic perspective in general, appear to be the basis of the popularly held belief concerning the negative relationship between development in rural areas and rural-urban migration.

*Intersectoral Linkages Models*. This approach emphasizes that different sectors are interconnected by systems of backward and forward linkages. Through such linkages, development in rural areas influences economic activities in urban areas and vice versa. Agricultural development is associated with increased demand for farm inputs; this backward linkage results in the growth of such urban activities as production and distribution of farm implements and machinery, fertilizer, new seed varieties, credit, and agricultural information. Forward linkages include transport and storage of agricultural commodities, other agriprocessing activities, and the wholesaling, transport, and retailing of agricultural based products. Both rural and urban jobs are created by agricultural growth.

Final demand linkages resulting from increased rural incomes are also important. Rural-produced goods tend to be income inelastic. while urban goods and services are generally income elastic; as their incomes rise, rural customers are expected to spend an increasing proportion of added income on urban goods and services. While added rural income will generate some additional demand for rural goods, it will have a much greater impact on demand for urban goods and services. To meet this added demand, urban production will increase, resulting in employment generation in urban areas and induced rural-urban migration.

The distribution of income gains in rural areas can have important implications for migration. The poorest rural families are apt to spend most of their additional income on basic foodstuffs which have little or no linkages to the urban sector. On the other hand, more well-off rural residents are likely to spend almost all of their added income on goods and services from the urban sector. Therefore, development activities which increase incomes of middle-level and more well-off farmers will have a stronger positive impact on rural-urban migration than activities which concentrate benefits on the poorest rural residents.

Intersectoral linkages have important implications for the pattern of rural-urban migration. Most of the urban employment induced by agriculture growth through backward (demand for farm inputs) and forward (agriprocessing, etc.) linkages will accrue to market towns and regional centers rather than big metropolitan cities. Consequently, backward and forward intersectoral linkages are likely to stimulate migration from rural areas to market towns and regional centers. Rural income growth also will increase the demand for consumer services in market towns and regional centers; the resulting employment generation will stimulate migration to these smaller urban cities. Employment generation induced by additional rural demand for urban products may accrue to primate cities (or even developed countries if products are imported), and thus stimulate migration to metropolitan areas; however, this depends on the particular industrial structure and consumer preferences.

Overall, the intersectoral linkage model suggests that rural-urban migration may be stimulated by development activities in rural areas which raise rural incomes. Most migrants will probably move to market towns and regional centers rather than into large primate cities. It should be noted that the definition of urban areas could affect the share of "urban" places of destination for migrants.

## Overview of Theoretical Models

Different theoretical models are in conflict concerning the impact on rural-urban migration of development activities in rural areas. Some theories suggest that migration will be stimulated while others imply that it will be reduced. General social theory of migration focuses on social changes associated with development that provide rural residents with more urban orientations and skills, which then facilitate migration. The intersectoral linkage model also predicts accelerated migration as development-induced increases in rural income are spent on urban goods and services, leading to urban employment generation and rural-urban migration. On the other hand, the Todaro expected income approach suggests that migration will decrease because rural-urban income differentials decline as a result of development activities in rural areas. The Sjaastad benefit/cost migration model suggests an ambiguous impact on migration, as both net benefits and costs of migration may decrease with development in rural areas. In short, theoretical models do not provide a clear-cut answer concerning the migration impact of development activities in rural areas.

## Empirical Studies of Migration

A large number of empirical studies have been conducted of internal migration in developing countries and several reviews of these studies are available. This section discusses the motivations for migration, characteristics of migration origins, and characteristics of migrants.

Motivations for Migration. Most surveys indicate that migration is primarily motivated by economic considerations, whether in Africa, Asia, or Latin America. Economic factors are cited in surveys of both reasons for leaving an area and reasons for selecting a specific destination. Studies of out-migration generally indicate that economic "push" factors are most important, while in-migration studies suggest that economic "pull" factors are predominant. This difference could be attributable to the locational context of the survey, i.e., "Why did you leave here?" versus "Why did you come here?" Also, those surveyed at rural origins and those at urban destinations may be samples of two different migrant groups, because rural out-migrants are not the same as urban in-migrants. Economic "push" factors may be most important to some migrants while "pull" factors are the primary concern of others.

Empirical evidence suggests that major economic "push" factors include agricultural un- and under-employment, lack of land, and general rural poverty, while the most important economic "pull" factor is the perception of high wages from urban employment. "Push" and "pull" factors are closely interrelated; those who are "pushed" into migration are simultaneously "pulled" by the hope of finding something better elsewhere.

Though empirical studies have indicated that economic motivations are clearly the most important, a number of other motivations for migration are found. Studies in Latin America, Subsaharan Africa, and Asia suggest that some rural-urban migration is motivated by a desire for the educational opportunities offered in urban areas. Other motivations cited in the literature include marriage (especially for women), joining the family already at the destination, escape from rural violence or war, and desire for urban amenities. Very little empirical evidence supports the popular idea that rural-urban migration is motivated by "bright city lights" or urban entertainment. The noneconomic factors are generally secondary reasons for migration; in the majority of cases economic considerations are the primary motive.

Characteristics of Migration Origins. Relatively few empirical studies have investigated the relations between origin characteristics and rates of rural-urban migration, although numerous investigations have been made of general out-migration without distinguishing whether out-migrants went to urban or rural areas. These studies suggest that out-migration is associated with land availability and origin economic characteristics.

A number of empirical studies indicate that rural areas with high out-migration rates tend to have high population densities, or high ratios of labor to arable land. A positive correlation between out-migration and lack of land is generally found for rural areas in Africa, Asia, and Latin America, although a few studies indicate a negative correlation. Making causal inferences from these correlations, however, is a problem: lack of land may cause out-migration, but out-migration also causes changes in land availability. Distribution of available land is also a factor in migration; evidence from India and Latin America suggests a positive correlation between high rates of rural out-migration and unequal distribution of land.

A number of empirical studies investigate the relationship between levels of rural development and rates of out-migration, with inconclusive results. Much of the evidence from Asian countries suggests that rural areas with low income levels or low crop yields tend to have relatively high rates of rural out-migration. On the other hand, studies from Africa and Latin America reveal high rates of out-migration from rural areas with relatively high levels of income or education. Relationships between income level and out-migration can be misleading because the causal direction is ambiguous. Low or high per capita income in a rural area may be associated with factors which could cause increased out-migration. Alternatively, high rates of out-migration could cause increased per capita income (if the poorest left, or if remittances were substantial) or decreased income (if better-off residents migrated).

Studies of rural areas in India, Colombia, and New Hebrides indicate a positive correlation between high rates of rural out-migration and commercialization of agriculture. However, evidence from Turkey suggests a negative correlation. Care should be taken in interpreting these results, because farmers may have migrated temporarily in order to obtain the funds needed to invest in commercial agriculture. The large number of studies which indicate that distance inhibits migration would suggest that rural areas which are accessible to and well integrated with urban centers should exhibit high rates of rural-urban migration, and this expectation is supported by the few studies which have explicitly investigated this issue. On the other hand, villages on the outskirts of cities may have low rates of out-migration because their residents can commute to opportunities in cities.

Clearcut conclusions are difficult to obtain, partly because most studies of rural out-migration fail to distinguish between rural-rural migration and rural-urban migration. Empirical evidence suggests that rural-urban migration is positively correlated with rural accessibility to, and integration with, urban centers; however, this generalization is based on relatively few studies. Many empirical studies indicate that lack of land is associated with high rates of rural out-migration; whether or not these out-migrants go to urban areas is not clear.

Characteristics of Migrants. A large number of empirical studies have investigated the characteristics of rural-urban migrants. In almost all cases, studies reveal that migrants tend to have relatively high levels of education (by rural standards) and are most likely to be young (15 to 30 years). In Africa and Asia migrants are more apt to be male, while in Latin America and the Philippines females predominate. Though the evidence is mixed, it appears that rural-urban migrants are more likely than rural nonmigrants to have nonagricultural occupational skills. Rural-urban migrants are also more apt to have made previous visits to cities, have friends and relatives in cities, and be more aware of cities and the opportunities they provide. In short, there is considerable evidence to suggest that rural-urban migrants are generally more qualified for urban life than rural nonmigrants.

A number of studies indicate that migration to the city is positively correlated with family income level. This correlation appears to imply that as a rural family's income increases, it experiences higher rates of rural-urban migration; such an implication is in direct contradiction to the expected income theory of migration (assuming expected urban income remains unchanged). The causal link between income level and migration is ambiguous; successful migration and remittances may cause high migration groups to have relatively high incomes. Income is associated with other characteristics which promote rural-urban migration such as education and occupational skill levels, aspirations, information and awareness, self-efficacy, intelligence, and attitude toward development. It is these other factors which seem to be positively linked to migration rather than income per se. If income could be increased without influencing any of these other factors, then income growth might possibly slow rural-urban migration propensity; but it is doubtful that this could result from a development activity.

A number of empirical studies support Lee's theory that rural out-migration is bimodal, that out-migration rates are highest for those at the medium-low and medium-high levels of the rural income distribution. Those from medium-low income groups tend to move to nearby rural areas or perhaps small towns, while those from the medium-high groups are more apt to move greater distances into larger urban areas. This type of migration flow (Figure 1) has been observed in countries of Africa, Asia, and Latin America. Better-off rural groups are more apt to migrate or send their educated youth to larger cities to take advantage of their higher education levels or modern skills. On the other hand, relatively poor groups can only afford to migrate short distances, and search for agricultural or unskilled work in nearby areas because they generally lack the education, skills, and information needed to compete in large cities. Moves to nearby small towns, however, could possibly lead to later migration to big cities after requisite urban skills, education levels, and information are acquired. The poorest of the poor are not expected to migrate because they lack funds for migration and are too preoccupied with survival. The middle-income rural residents might be less apt to migrate because they are fairly secure as farmers, sharecroppers, or petty entrepreneurs and they lack the urban skills which might motivate migration.

Summary. Empirical studies reveal a number of generalizations concerning internal migration in developing countries, several of which are relevant to the issue of the development impacts on rural-urban migration. Relevant generalizations are listed in Table 1. Each empirical generalization in the table has implications concerning development activities in rural areas shown on the right side of the table. The table suggests that many development activities may tend to stimulate additional rural-urban migration; however, the impacts of actual development projects will depend upon the type of development activity undertaken.

Figure 1

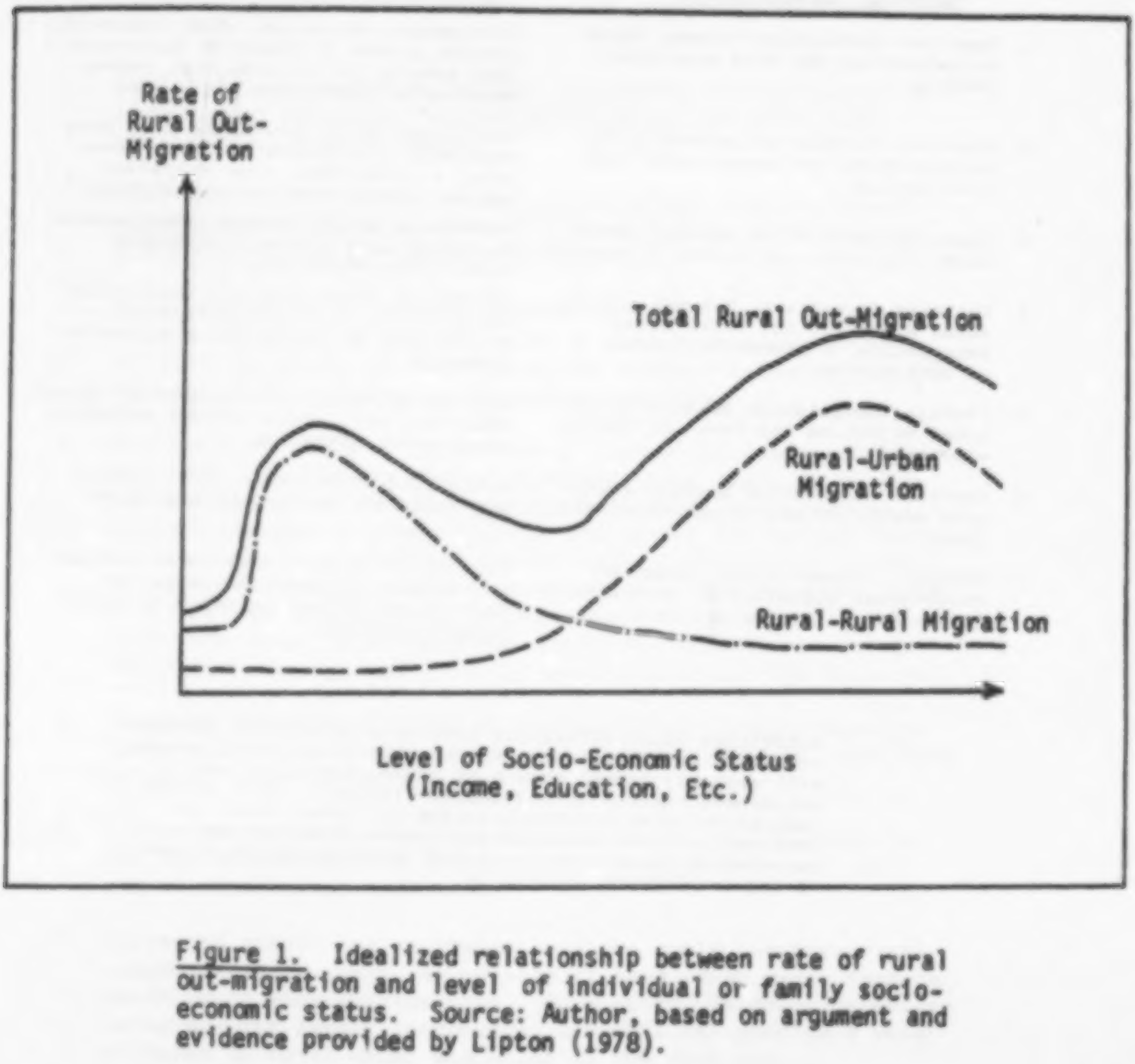

Figure 1. Idealized relationship between rate of rural out-migration and level of individual or family socio-economic status. Source: Author, based on argument and evidence provided by Lipton (1978).

Table 1. Implications of Empirical Studies Concerning Migration Impacts of Development Activities in Rural Areas

| Empirical Generalization | Implications for Development Activities |
|---|---|
| 1. Positive correlation between rural out-migration and high population density. | Development activities which reduce population growth or increase cultivatable land should, in the long run, reduce rural-urban migration. |
| 2. Positive correlation between rural-out-migration and unequitable land distribution. | Activities which distribute land more equitably will probably reduce rural-rural & rural-small town migration, and may reduce rural-city migration.[a] |
| 3. Positive correlation between rural-urban migration and access to cities. | Activities which increase rural access to cities will probably stimulate rural-urban migration. |
| 4. Positive correlation between rural-urban migration and rural-urban integration & commercialization of agriculture. | Activities which increase rural-urban integration and commercialization of agriculture may stimulate rural-urban migration.[a] |
| 5. Positive correlation between rural-urban migration and level of formal education. | Activities which raise levels of formal education will almost always stimulate rural-urban migration. |
| 6. Positive correlation between rural-city migration and occupational skill level. | Activities which raise skill levels may stimulate rural-city migration. |
| 7. Unclear, assumed mixed impact on rural-urban migration of development-induced rural income growth. | Activities which raise rural incomes may either increase, decrease, or have no net effect on rates of rural-urban migration.[a] |

[a] Activities which distribute land more equitably, increase commercialization of agriculture, and raise rural incomes will probably induce growth of urban production and employment through intersectoral linkages. Most of the induced growth will probably accrue to market towns and regional centers; consequently, these urban centers are expected to experience increased in-migration as a result of the development activities.

## Migration Implications of Specified Rural Development Activities

Different types of development have different implications for migration. Each activity has a set of associated impacts, some of which may accelerate migration while others tend to slow rural-urban movement. Because of these counteracting impacts, it is not easy to make broad beneralizations. The influence of an actual development project on migration depends in large measure on specific characteristics of the project and of the area into which it is introduced. With this caveat in mind, the following tentative generalizations are offered:

1. Land reform is expected to have a moderate slowing impact on rural-urban migration because it normally increases labor utilization in rural areas.

2. Land rent ceilings and tenancy controls may lead to tenant evictions and thus may stimulate rural outmigration and possibly contribute to rural-urban migration.

3. Rural resettlement schemes provide opportunities for varying numbers of people; their ability to have a negative impact on rural outmigration depends on the numbers affected and the success of the schemes in retaining settlers.

4. The Green Revolution (promotion of high-yield seeds, fertilizer, etc.) in the absence of tractorization tends to be labor absorbing and therefore may reduce rural outmigration. Rapid increases in production of grains for the market tend to stimulate the growth in market towns and regional centers of agriprocessing, supply of farm outputs, and consumer goods and services. Therefore, through these intersectoral linkages, the Green Revolution may stimulate migration into market towns and regional centers, particularly in the long run.

5. Tractors and related forms of mechanization usually displace labor and thus stimulate rural outmigration and may contribute to rural-urban migration.

6. Irrigation projects increase the demand for agricultural labor and therefore tend to slow rural outmigration and may reduce rural-urban migration.

7. Increased credit and extension services could increase rural output and employment, especially if they reach small farmers, which could slow outmigration. More often the chief beneficiaries are the larger landowners, and this may provide a weak stimulus to rural-urban migration in the long run.

8. Off-farm employment and rural enterprise development tend to generate economic opportunities in small towns. Such activities stimulate rural to small town migration and may retard rural to big city migration in the short un. However, in the long run, migration to large cities may accelerate because small centers often act as a staging ground for rural migrants on their way to large cities.

9. Rural public works projects provide attractive employment opportunities, and therefore have a strong negative impact on rural-urban migration. After project completion the impact may shift to a moderate stimulus to rural-urban migration because public works programs can provide rural workers with the occupational skills and experience needed to gain urban employment.

10. Rural roads projects generate considerable employment during construction; thus they may have a strong slowing impact on rural-urban migration in the very short run. However, upon completion, the improved roads increase rural-urban integration and thus may stimulate rural-urban migration.

11. Rural electrification also increases urban-rural integration and thus may accelerate rural-urban migration. However, electricity can stimulate rural economic activity thus retarding migration. The net impact is probably a weak slowing of migration.

12. Development of rural education may keep some youth and even their families from moving to towns where schools are better. However, formal education provides youth with skills that are far more applicable in cities than in rural areas; consequently, development of formal education provides a very strong stimulus to rural-urban migration. This is perhaps the strongest generalization that can be made concerning the impact of rural development activities on migration.

13. Family planning programs which reduce fertility and population pressure on land have a moderate slowing impact on rural-urban migration in the long run.

14. Development of improved rural health services has a mixed and relatively weak impact on rural-urban migration.

15. Most of the expenditures for the rural-oriented activities of international development agencies are made in large, often capital, cities for such items as salaries, office overhead, farm equipment and supplies, and travel. The direct and multiplier impacts of these expenditures generate considerable em-

Again, it must be remembered that these generalizations are tentative at best; actual migration impacts of specific development activities can only be assessed with any degree of confidence on a case by case basis.

### Conclusions

The results of this investigation suggest that past development activities in rural areas, taken as a whole, have not resulted in any appreciable reduction in rural-urban migration. In fact the evidence appears to suggest that rural-urban migration probably has on balance been stimulated by previous development projects in rural areas. It is doubtful that future projects will be much different from past projects in this respect. In almost all cases, development activities in rural areas cannot be justified on the grounds that they slow rural-urban migration. This is one of the most definite and important conclusions of the present study. There are reasons for believing that existing rural-urban migration flows will not be reduced no matter what types of development activities are undertaken in rural areas. Most such development activities tend to have a mixture of positive and negative impacts on migration, and many of them appear to have a net positive impact on rural-urban migration. While a few types of activity may slow rural-urban migration in the short run, their long run impacts are generally mixed or perhaps even stimulative.

It appears that making changes in urban areas is the most promising approach to influencing rural-urban migration. Suggested changes for reducing urban immigration include urban wage restraint, elimination of urban minimum wage, removal of subsidies to urban industries, and easing of food price ceilings and urban food subsidies. These changes might reduce urban migration; however, they are very unpopular politically and, therefore, have little chance of being implemented. It seems more practical to remove some of the more obvious subsidies enjoyed by urban areas, while accepting the inevitability of rural-urban migration and dealing with development and poverty problems where they presently exist and are expected to be in the future. But even though rural-urban migration seems inevitable, it might be possible to influence the pattern of migration by promoting development activities which stimulate employment generation in regional centers or small cities. Such activities might be more effective in reducing migration to primate cities than development activities in rural areas.

[Extracted from a monograph published by the Office of Urban Development, U.S. Agency for International Development, Washington, D.C., March 1979.]

# Urban Bias and Food Policy in Poor Countries

Michael Lipton

[Policies affecting food supplies tend to reflect urban influence and interests rather than rural interests in most developing countries. This has a negative impact on food supplies, especially on foods available to low-income consumers.]

By 1950 the less-developed countries (LDCs) of Africa, Asia and Latin America had about regained pre-war levels of real income per person. In the next 25 years these levels rose on average by over 75% in real terms--almost certainly more than in the previous 25 centuries. Yet, such improvements have done little to raise the nutritional levels of the poorest 30% of the people of most such countries. Typically, one of the 920 million persons in the poorer half of the populations of India, China, Indonesia, Bangladesh, Nigeria and Brazil spends 55-80% of any extra income on food. The less poor half of these countries' populations, however, spend a much smaller share of extra income on food--typically 20-35%--and most of this goes to vary the diet and simplify cooking, not to provide extra calories. Moreover, a larger proportion of poor than of less-poor people is dependent on agriculture in LDCs. Stagnation in the incomes of poor people in LDCs, combined with enrichment of less poor people, is therefore almost certain to be matched by (a) very slow, if any, growth in calories consumed per person in those countries, and (b) much faster growth in the production of non-food and non-agricultural commodities.

This is just what has happened. Despite local successes--like Sonora in Mexico and the Indian Punjab --food output per person in the developing world is not

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World as a whole. But these extra imports have done little for the poor and hungry, for four reasons. First, the proportion of food provided by imports is small in most poor LDCs (only 3-5% of world output of rice, the main Asian staple is usually traded). Second, food imports seldom durably or substantially alleviate the condition of the hungry in LDCs: of the Third World's poor, over 80% live in rural areas, and are unlikely to have access to imported food. Third, many of the rural poor are involved in food production, and hence lose if imports cut food prices; this decrease in ability to buy food may offset nutritional gains to those who get the imported food. Fourth, worsening income distribution in LDCs has shifted their patterns of demand, and hence of both outputs and imports, away from "poor men's foods," such as millet, towards such costly calorie sources as meat, milk, fruit and vegetables--a shift accentuated by government policy.

It is not surprising, then, that--according to aggregate FAO data--the poorer half of the people in India, Bangladesh, Indonesia, Nigeria or Brazil probably get no more food now than in 1934-38, although their countries' real income per head is some 40-80% higher. Direct tests via diet surveys or food balance sheets--while often methodologically dubious--on the whole support this alarming conclusion.

## Urban Bias

*Causes of "growth-with-hunger*." The sorts of decision that have led to growth-with-hunger in many LDCs are gradually becoming understood. First, growth requires the diversion of resources away from making consumer goods towards investment in the broadest sense--towards paying teachers and doctors as well as building factories and dams.

Second, and much more important, too few of the resources diverted from consumption have been used for agricultural production. In the 22 LDCs with available data, barely 20% of investments in 1950-65 reached the agricultural sector. (FAO, *State of Food and Agriculture 1978*, recorded little change.) Yet it typically engages 70% of population to make 45% of output. This neglect of agricultural investment is not due to its low returns; even in 1960-65, before the "green revolution," it was typically associated with about three times as much extra output as investment elsewhere in the economy.

Third, urban pressures have caused even this inadequate agricultural investment to be misdirected. It has gone to huge dams (enriching urban contractors and often providing urban electricity) instead of to higher-yielding minor irrigation. It has too often favored export crops and "rich men's foods," with scant regard for calorie output per acre or per unit of investment. Above all, it has supported the big farm that supplies outputs for urban users, although the small farm that feeds the rural poor and has easy access to family labor makes more efficient use of land, fertilizer, water, and other inputs, and hence produces more output from them.

Fourth, a whole array of policies, from price incentives and import licensing to the allocation of administrators and doctors, has persuaded people to transfer efforts and resources from rural to urban areas, from agriculture to industry.

Why urban bias? It is gradually becoming possible to interpret and compare these policies across LDCs, and to show that they cannot be substantially justified by any success in accelerating industrialization. Less easy--but necessary, if one is to illuminate the consequences for food policy--is to explain how they have come to be normal in so many LDCs. The shared errors of a hundred or so governments cannot sensibly be attributed to evil, or ignorance. Most LDCs have nationalist governments; many are democratic, or have "populist" overtones, or leaders who advocate (at least verbally) some form of socialism or egalitarianism. Yet almost all LDCs--the few exceptions, including Taiwan and South Korea as well as Cuba and China, make a fascinating group--have been permeated by urban bias: by the tendency of public authorities and private persons to allocate, and their disposition to justify proportions of developmental or welfare-generating resources for large urban areas, in excess of any reasonable norm of either efficiency or well-being. How is this possible?

The answer is hinted at by comparing the political and economic structure of today's LDCs with that of "Now Rich Countries" (NRCs) at a comparably early stage in accelerated growth. There are nine NRCs and 64 LDCs for which ratios of non-agricultural to agricultural income-per-person in early modern development are available. All but two NRCs showed a lower ratio than do 63 of the 64 LDCs; and two-thirds of the LDCs show a higher ratio than did any of the nine NRCs. Typical ratios for NRCs in early development range from 1.3-1 to 2-1. For Asian and Latin American LDCs today, ratios run from 3-1 to 5-1; and for Africa today, from 4-1 to 8-1. These disparities result from, and (since wealth breeds power) cause, inequalities in political "clout" between the rural sector and the urban sector, dependent as they are on agriculture and industry-cum-commerce respectively.

The NRCs in early development were actually more urbanized, but less prone to under-represent rural interests, than are LDCs today. In Britain in 1811, only 35% of people lived off agriculture; yet the farm interest was strong enough to secure protection for agriculture right through its critical innovative period, ending with the Corn Law abolition in 1846. In much of today's Third World, some 60-80% of people live off agriculture; however, an urban-industrializing ideology, good communications, and the power given to urban groups by their leadership in the anti-colonial movement, have enabled these groups to seize much more power than did their NRC predecessors; and it is industry that is protected by tariffs or otherwise, while agricultural prices are deliberately held down. It is not only that in today's LDCs the townspeople, though proportionately fewer than in the NRCs, are stronger, but that the rural masses are on the whole more dispersed, less organized. less literate, and thus--if successful--more easily "bought off" by the urban interest, than were their counterparts in NRCs. Such resources as do go to agriculture are steered by urban interests toward bigger farmers who--though less efficient than small ones--are likelier to sell their output to cities, to reinvest their savings there, and to underpin the political status quo. Conventional coups, even revolutions, seldom help the rural poor much; rather they redistribute power towards previously disaffected urban groups.

This is an overcompressed and hence oversimplified account (details appear in M. Lipton, *Why Poor People Stay Poor*, Harvard and Temple Smith, 1977), but it is necessary for an understanding of the determinants of LDCs' food policies, to which I now turn. A population's nutritional condition is determined by the amounts and composition of the country's food outputs and of net food imports, and by their distribution both among persons (between the undernourished and the overfed) and over time (between lean and good years and seasons). These amounts, distributions and compositions in turn depend partly on nature, discovery and preference, but partly on three types of policies. The first type affects food output (and net imports) directly, e.g., via incentives to agriculture as a whole, to particular crops, or to exports or imports of food. The second type affects the amount, composition, and distribution of agricultural inputs. The third type affects the conversion efficiency of such inputs into food and other outputs. The rest of this paper will indicate how each type of policy has been affected by urban bias, with consequent damage to nutrition.

## Policies Directly Affecting Food Availability

Most LDC governments have been more concerned that food availabilities shall support industrialization without strain upon the balance of payments or the price level, than that they shall suffice to feed people properly. This may seem a harsh judgement; it owes its truth not to political wickedness but to advisory amorality and urban pressure; but true it is. Evidence is provided by two of the commonest approaches to food planning in poor countries: the drive to self-sufficiency, and "income-elasticity planning." The first impedes any increase in total food availability; the second ensures that food supplies are structured to please the greedy, not to feed the needy.

*Self-sufficiency planning*. Most big countries seek self-sufficiency in food. As a general aim this may seem hard to fault. The economist may argue that free trade could enable some LDCs to eat more if they produced non-food and traded it for food, or that imported farm inputs can be costly; but great reliance on food imports can be terribly risky, and I am not defending the pure free trade position. It is the manner in which "self-sufficiency" is usually estimated that is at fault.

Typically, the planners first arrive at some average of foodgrain intake per person. Next they work out how much extra output of the nation's main food crops is needed to replace imports and supply that intake entirely from domestic production. Finally, they seek to provide the farm investments and inputs judged necessary to replace imports at the required level.

The procedure has many faults. It emphasizes the main domestic crop, often at the cost of cheaper ways of producing calories; thus Sri Lanka's drive towards "self-sufficiency in rice" in 1965-70, apart from being only partially successful, obscured the high caloric returns to investment in manioc production, and confirmed the long-standing neglect of that crop. Even in foreign-exchange terms, it can produce odd results; part of Sri Lanka's "success" in cutting rice imports was achieved at the cost of a huge bill for imported wheat flour. Above all, the thrust towards a static "self-sufficiency"--in a single food crop or even in total calories--at once fixes average nutritional standards at initial levels, and does nothing (or, as in the manioc-rice case, less than nothing) to get more calories to the undernourished.

For example, in 1972/3, the planners in Bangladesh decided on the following aim: five years later, in 1977/78, the country should supply its own "foodgrain requirements" of the late 1960s and early 1970s (about 15 oz. per person per day), instead of importing some 10-15% of those "requirements" as had been typical of these years. That may sound sensible, but food is the very last import, nutritionally speaking, that extra food output in Bangladesh should replace. For consider the following implications of a target of "self-sufficiency" at the meager levels of 1972/73: to set as the standard a level of grain consumption per person which (given that grain provides some three quarters of all calories) is insufficient even as an average; to do nothing, therefore, for the poorer 50% of the people of Bangladesh, who eat perhaps 65-75% of that inadequate average; to use domestic rice to *replace* (instead of to supplement) imported wheat, creating serious transport problems for food deficit areas in or near ports that must instead be serviced from (often remote) domestic rice-surplus regions; and possibly (by shifting from imported wheat to home-grown rice) to reduce protein absorption per lb. of grain.

The best one can say for a "push to self-sufficiency," as against a food drive that *supplements* imported calorie sources, is that it may increase food prices to farmers, thus encouraging further domestic food output later, and providing incomes to farmworkers and subsistence families. But there are other, less nutritionally damaging ways to do this than to perpetuate inadequate and maldistributed availabilities of total foodstuffs. Indeed, many LDCs seeking "self-sufficiency" in this way have at the same time done much to force producers' food prices down--by as much as two-thirds of their real value in Pakistan in the early 1960s! Probably, therefore, a decision to use extra domestic output of calories to replace food imports, rather than to improve nutrition, is motivated by a wish not to keep up prices for poor farmers, but to free foreign exchange to buy the imports needed as inputs for investment and current production in heavy industry, transport and urban construction.

Such planning prevents increases in food availability. More home output of food just means that the planners permit fewer food imports. Other pieces of planning have similar effects: the measures, almost Third-world-wide, to keep food cheap for urban consumers discourage its production at home. Underinvestment in agriculture does not help either; and the human under-endowment of rural areas--their relative lack of teachers and doctors, engineers and administrators--indirectly reduces food output, both by removing some of the relevant skills and by rendering the countryside unattractive to the successful farmer.

Income-elasticity planning. Another centerpiece of urban-biased food planning--the income-elasticity method--damages, not the output and availability of food, but the ability of poor people to afford the food that is available. It does this in four ways: by biasing the structure of food output towards items consumed by the urban rich; by raising the price of poor men's foods; by making the distribution of income more unequal; and by helping food processers to dispose of what is most profitable in disregard of nutritional need.

The income-elasticity of demand for a commodity is the percentage increase in the amount of it consumed when there is a 1% increase in the total income in the community consuming it. Planners using the income-elasticity method, and seeking to project requirements of a foodstuff five years hence, first look at recent surveys of consumption of that foodstuff by people in various income groups; then estimate how many people will be in each income group five years hence, taking account of likely rises in income and of population increase; and finally--assuming that income-elasticities of demand, among and within groups, stay the same--use the above information to estimate total demand for each foodstuff. Production policy, and (where imports are controlled) trade policy, are then geared to meet the calculated pattern of demand. Since urban and rural food consumption patterns differ, it is a common refinement to use separate survey data for urban and rural income groups, and to estimate separately the size of such groups and hence their food demand at the end of the plan period.

If the hidden assumptions of this approach are acceptable, there is nothing (or at least nothing insuperable) wrong with it technically. But, since the approach instructs the planner to provide for food demands and to ignore food needs, the assumptions have to be questioned--not technically but morally. There has to be something wrong with a program that instructs us that because income per person has grown, we should then cut back on production in the kinds of foodstuffs eaten by the poor and hungry. In poor countries it is usually the non-hungry whose incomes grow fastest; rich people's incomes, urban income per head, and urban populations usually outpace, respectively, poor people's incomes, rural income per head, and rural populations.

The wrongness is sometimes obscured by the superficial attractions of some inappropriate foods in demand by people with money to spend. This applies to the wasteful and antinutritional responses of tastes to urban advertising--for example tastes for white bread, highly-polished rice, soft drinks, or "hygenic" beers replacing nutritious local brews. Also usually inappropriate, if more subtly so, are meat and dairy products as protein sources, and fruit and leafy vegetables as vitamin sources: such costly "ideal" foods appeal to pure or westernized nutritionists, but not to the purses of the hungry.

The damage is done in four ways. Most simply, planning that encourages the farmer to devote more resources--especially land--to rich men's foods, leaves fewer resources for poor men's foods. This is both inequitable and calorically inefficient when lands that might grow cereals or pulses are diverted to meat or milk animals (normally producing only 15-25% of the calories per acre). Similar effects occur more subtly when marginal lands, finely poised economically between producing plenty of "low-grade" calories for the poor or fewer "high-grade" calories for the rich, are shifted from maize to wheat, or from millet to rice, by policies catering excessively to the food preferences of urban people enjoying rising incomes. Income growth and urbanization can induce such shifts; but while hunger lasts, government policy should discourage them.

Second, the accompanying shifts make poor men's foods dearer, and rich men's food cheaper. Land diverted from foodgrains to feedgrains; maize and pulses diverted from poor people to feed cattle for meat and milk production; research into fruit and milk-cows or even, where people are very poor, into wheat and rice rather than millet--all this, by cutting the supply of poor men's foods and rendering them relatively scarce, increases their prices. The corresponding relative price reduction in the nutrients of the better-fed is scant compensation. There is, to be sure, some farmer reaction towards growing "poor men's foods" as their price rises; but this reaction is kept weak by the poverty of their buyers, and by government emphasis on areas producing other foods in policies affecting research, water development, and fertilizer supply.

Third, the resultant worsening of income distribution means that many poor people--notably deficit farmers and landless laborers who grow and eat millet or maize in the semi-arid regions of Africa and Asia--have fewer prospects of correcting their nutritional deficiences. Not only do the extra millet or maize, over and above on-farm production, needed by these people to make good their deficits, become scarcer and more costly, but such consumers become poorer in real terms, and less able to buy other sorts of food.

Fourth, the tendency of urban-biased, capital-intensive, pro-industrial development policies to raise chiefly the incomes of the urban rich would in any case mean more demand--and hence more production and import of rich men's foods; but some of the effect would be felt as price rises for those foods which could discourage some consumption of them. However, planners wishing to accelerate a shift toward "modern" agriculture can cause most or all the effect to be felt as higher production (and imports) at the expense of the supply of poor men's foods. "Consumers' sovereignty" under unequal, urban-biased growth is bad enough; helped by planners, it is worse; and the effects can be further augmented by highly organized industrial firms. The increasingly organized food industry will process and advertise what is profitable, and that is only too likely to mean packaging, prepared baby-foods, highly polished rice, and similar status-conferring and often nutritionally harmful devices. Planners concerned with the relief of hunger should resist such currents, not give them "income-elastic" support.

Planning against hunger. Is there any alternative to these urban-oriented approaches to planning food availability--to the drive towards a static self-sufficiency, and to the determination to supply at the going price whatever is demanded out of extra incomes? The commonsense alternative, surely, is first to identify the numbers and types of people in nutritional need and the size of their deficiencies; then to select the cheapest methods of producing or importing what is needed to make good those deficiencies, and of distributing the extra food or the power to buy it to the people suffering them; and finally to implement these methods, beginning with the most cost-effective that is politically feasible, and continuing down the scale of cost-effectiveness until almost all undernutrition has been abolished.

This picture of nutrition programming needs refinement: but, by giving sufficient priority (say 15% of allocable resources) to making calories securely available to the hungry, almost any LDC could eliminate 90% of its undernutrition in ten years, within its existing political framework. It is the self-defeating quest for instant industrialization pushed on the Third World from East and West alike, and its convenience to powerful urban groups (government, intellectuals, and organized labor, as well as business), that have pushed aside the abolition of hunger as the main task for planners of food availability. It is a task not only feasible technically and economically and desirable morally, but also highly practicable politically. Urban bias in food policy is not a law of political nature.

## Policies Affecting Inputs Into Food Production

In considering the search for the cheapest methods to obtain the missing calories and to get them to the hungry, I have taken up the volume and structure of farm output. Equally affected by urban bias is policy affecting farm inputs: their total, their composition, how many and which ones reach poor farmers, and how many and which go to produce food.

*Curtailed inputs into food production*. To stress investment in industry, housing and roads--and hence to cut back on investment in irrigation, drainage and farm implements--is to reduce total available farm inputs from such sources. Farmers may well find that inadequate infrastructural investment in rural areas makes the purchase of other current inputs unprofitable or risky. Extra water is often necessary to justify major extra inputs of nitrogenous fertilizer, for example, and control of drainage and erosion is essential if a farmer is to retain, on his own land, the benefit of fertilizers or pesticides that he has bought.

Private persons are often not encouraged to make good the gaps in public provision of farm inputs. Institutional credit is heavily concentrated on urban activities; and a farmer seeking to buy an improved plough with private credit must compete with heavy consumer demands that force interest rates up. Subsidization of scarce farm inputs misdirects them to the bigger, more powerful farmer, who alone has the influence to get them. Thus, if the policy is "subsidy plus scarcity" the small farmer probably gets fewer inputs than before. Finally the underpricing of farm outputs, and the protection and overpricing of industrial outputs, is a standing deterrent to the use or provision of farm (as against industrial) inputs.

*Input structure*. The type of farm inputs fostered by policy makers in ways beneficial to powerful urban groups has also retarded the abilities of poor rural people to afford enough food, and of scarce rural land to supply it. Given the amount of public and private spending on agriculture, it has been allocated excessively to the subsidized provision of inputs which do little for poor people's nutrition, but much for urban contractors and urban requirements of marketed rural raw materials.

Thus, large-scale tractorization in many poor countries--highlighted by the ILO World Employment Program's reports on Kenya and Sri Lanka--has spread far beyond areas of seasonal labor shortage. Such shortages can be met by several other methods more likely to create income for poor workers, not rich tractor-owners. Such methods, indeed, are widely adopted where tractorization is not artificially encouraged as by subsidy. In most cases--Northern Mexico and the Indian and Pakistani Punjab are exceptions--tractorization in LDCs has done little to raise output (Binswanger, *Economic Tractorization in*

*South Asia*, ADC, New York, 1978) but has worsened rural unemployment and hence undernutrition, and has encouraged large-scale farming to "save labor" (i.e., create unemployment), even though smaller units tend to grow more grain per acre (for recent evidence see R.A. Berry and W.R. Cline, *Agrarian Structure and Productivity in Developing Countries*, Johns Hopkins, 1979) and are more likely to feed it to hungry people. Meanwhile the foreign exchange devoted to importing tractors has been unavailable for the job-creating fertilizers needed to raise food output. The energy crisis, given the fuel needs of tractors, has sharpened these contradictions, and others. If oil shortages cause a rethinking of the capital-intensive, big-farm strategy, small farmers and low income consumers may yet be grateful for them.

*Who gets inputs?* The planner who is seeking to support industrialization with farm surpluses will not be eager to see scarce inputs going to small farmers who consume the outputs themselves. And we have seen how the planners' choices of types of input, and of credit policy, hamper small farmers in getting inputs. Why is it nutritionally desirable that they should? First, since they have more labor per acre, and since the farm family controls it and keeps the total returns from most of it, they apply more effort per unit of inputs, and hence grow more from them. Second, subsistence farmers are likelier to grow extra food from extra inputs than are large farmers. Third, being poor, they are more likely to be hungry, so that extra food (or extra income) improves their nutrition.

*How inputs are used*. The final issue, on which urban bias has historically reduced the impact of farm inputs on food output, is the allocation of those inputs among uses. If governments seek only to cater for *growth* in demand (especially among the less-poor) they will discourage farmers from applying water or fertilizers to poor men's foods. Moreover, research has characteristically stressed improved inputs, notably seeds, for commercial export crops. This colonial tradition, based partly on the reliance of governments upon revenue from export taxes and marketing boards, persisted well after independence in most LDCs, and helps explain delays in their "green revolution" in wheat and rice. Even today, research and extension, and fertilizer use, per acre of tea or cotton have typically been pushed far nearer to their economic optimum than for rice and wheat, let alone millets and manioc.

[Extracted From *Food Policy*, Vol. 1
No. 1, November 1975, pp. 41-50.
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Guildford, Surrey, England.]

# Regional Planning to Strengthen the Contribution of Urban Centers to Rural Development

Eric Chetwynd, Jr.

[Regional planning for towns and cities has recently been given a new emphasis on its services to rural growth. This article describes some projects in which this kind of planning is developed.]

The approach to regional development known as the "spatial systems approach" was widely accepted by the mid-1970s. Its view of the economic growth process as moving downward through an urban hierarchy from the biggest cities to smaller cities, towns and villages has been described as follows:

> "Economic growth and development are initiated and reach their highest levels at a few centers which offer advantages for industrial location and have a high capacity to generate and adopt innovations. Growth impulses, in the form of market demands for goods and development-inducing innovations, diffuse from these centers to the rest of the space economy through a hierarchy of urban industrial centers, and through a network of smaller central places which serve as marketing and service centers for the rural population. Diffusion from these centers into surrounding rural hinterlands occurs in a wave-like process which is subject to considerable distance and time delay." (1974 Paper by AID's Office of Urban Development)

The principal weakness of this model, as observed in practice, is that the beneficial impacts that flow from the few privileged centers at the top of the urban hierarchy often are limited to their immediate contiguous areas and do not penetrate sig-

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nificantly into the rural hinterlands. Without a well-developed system of intermediate cities, towns and smaller centers to form an integrated marketing and distribution system, the rural farmer who is not within commuting distance of a major center must depend upon the village for all his supplies and for marketing and other basic services. Yet, since the level of transportation and other services is very low in most villages, a large proportion of rural families are excluded from the mainstream, and often even from the marginal benefits, of the national or regional development process.

As a first step in addressing this problem, the Office of Urban Development sponsored a study which produced the basic guidelines for the projects which are the subject of this paper. The resulting monograph was published by Praeger in 1978 as Urbanization and Rural Development: A Spatial Policy for Equitable Growth. Originally it was called Urban Functions in Rural Development. The study explores the inequities in the spatial distribution of services in developing countries, examines the various approaches to this problem in theory and in practice, and evaluates the programs of international development agencies in this context and finds them deficient. The study then attempts to explain how urban services and facilities can be strengthened to support rural development. It sets out an operational strategy for integrating urban and rural development, in which the starting point is an assessment of the gaps, weaknesses, and deficient linkages in the capabilities of a regional system of cities, market towns, and service centers to serve surrounding rural areas.

## Some Definitions

Hierarchy of centers. The following terms are used in AID's regional planning programs. A hierarchy of urban centers--service centers, market towns and regional centers--serves a rural region and binds it together. At the bottom of the hierarchy, and normally in closest proximity to the farms and villages in any given region, are the service centers. Following the general pattern of regional population density, they offer the most fundamental types of services not available on the farms or in the villages. These services will include at least some combination of periodic markets, storage facilities, some permanent vending stalls, perhaps some basic agricultural processing facilities such as mills and presses, a primary school, a dispensary, and the lowest level of central or regional government representation. Service centers are accessible through one or more farm-to-market roads or trails, and normally will have some kind of road link with the next higher order center which is the market town.

Market towns are more complex than service centers. They offer a wider range of services to a more extensive service and exchange area that may include up to six or more service centers. In addition to permanent markets or large and frequent periodic markets, the market town can include small manufacturing and processing plants, farm supply and servicing centers, banks and agricultural credit services, blacksmiths, clinics, secondary and vocational schools, subregional government services or installations and basic recreational facilities such as bars, cafes, and sports fields. Market towns usually will have a decent road connection with the highest order of centers at the regional level, the so called regional centers.

There may be only one or as many as several regional centers in a region, depending on its size, population, and level of development. Regional centers tend to be major sources of employment, offering large, complex markets, specialty stores and specialization in a whole range of productive, commercial and professional services. Hospitals and higher education facilities normally are found in regional centers and there can be a variety of cultural and entertainment services. Regional offices of the government are located at this level. Regional centers are usually linked to the capital and other major cities by all-weather roads, and sometimes rail and air service, and they can be linked with international markets and communications networks.

These characterizations are intended to represent a kind of normative model. Obviously the combination and nature of services in any actual town or city will vary with its size, age and location, the nature of the local rural economy and other related factors.

*"Urban functions" in rural development*. To support growth in its rural hinterland, an urban center must: a.) be accessible to the farmers; b.) have transport and communications links to the higher centers; and c.) provide (directly or indirectly) the following services: (1) marketing, storage, and refrigeration of rural produced goods; (2) agricultural processing; (3) agricultural credit; (4) merchandising of agricultural inputs and machinery; (5) services for farm equipment; (6) sources of technical information and advice; (7) health, education, and administrative services; and (8) cultural and recreational services.

## Urban Functions in the Bicol River Basin

The Bicol River Basin is one of seven major river basins in the Philippines around which the Philippine government is building its regional development strategy and program. Located in Southern Luzon, it encompasses two provinces totalling 706,000 hectares and has a system of about 120 service centers, market towns and regional centers. The Bicol Basin was selected for the first or demonstration regional development (integrated rural development) program because, while it holds considerable promise as an agricultural region and its people are noted for their industriousness, its population of nearly 2.0 million has one of the lowest average incomes in the country. The region sustains an annual battering by typhoons and floods, and its people wage a constant struggle to overcome the effects of the tidal backwash which often accompanies typhoon flooding and leaves thousands of acres of farmland salinated.

The Bicol River Basin Development Program (BRBDP) was started in the early 1970s as an integrated rural development program designed to alter the fortunes of this economically depressed region. Of necessity, the program contained a heavy flood control and irrigation component and was most comprehensive in its other aspects as well. It was a multi-faceted program intended to deal with all of the significant elements of agricultural and rural development from agricultural credit, cooperatives, and extension services to marketing and transportation. One major deficiency in the program was its lack of a spatial orientation. It lacked a strategy for dealing with the role of urban centers and their connecting linkages in the physical organization and economic integration of the region.

A project agreement was signed in June of 1975 which made available an AID grant of $250,000 to assist the Bicol River Basin Council in "reorient(ing) urban development in the Bicol River Basin in the context of its rural agricultural character, such that its urban centers directly complement and support the planned integrated development of the Basin area." A multidisciplinary Philippine project team was assembled, headed by an urban and regional planner. The team was set up as a staff within the BRBDP and had formal consultative contracts with the University of the Philippines and the Center for Policy and Development Studies at Naga in the Bicol River Basin.

The project was to develop a process that would facilitate application of the "urban functions in rural development" approach not only in Bicol but elsewhere in the Philippines, and in other countries. Because it was the first field application, the selection and use of analytical methodologies in the Bicol project were characterized by trial and error. A number of approaches were found to be inappropriate for the conditions and data base in the Philippines and had to be altered or rejected outright. Basically, the steps followed were:

a. Socio-economic, demographic and physical profiles of the municipalities (similar to counties) to serve as an inventory for comparative analysis and baseline data.

b. Analysis of the existing hierarchy of settlements to determine centrality (relative importance) of centers, the relative complexity of their functions, and the ranking of settlements. This analysis was attempted through a series of three methods, each of which was found to be an improvement on the last, namely:

(1) A Guttman scale analysis of built-up complexity based on municipality profiles;

(2) Calculation of weighted centrality by assigning predetermined weights to different functions; and

(3) A scalogram analysis for the 120 most important population centers (or built-up areas) in the basin. The scalogram proved to be an extremely useful graphic inventory and display of the presence or absence of key functions in a regional hierarchy of centers (see illustration in Figure 1).

c. Threshold analysis to determine approximately what population size is needed to support a given level of services.

d. Linkage analysis (including mapping and overlays) to determine the extent or lack of physical and economic integration among centers, and between centers and their hinterlands. Separate analyses were done for:

(1) Transportation and physical linkages;
(2) Economic and market linkages;
(3) Service linkages;
(4) Social linkages; and
(5) Administrative, political and government linkages.

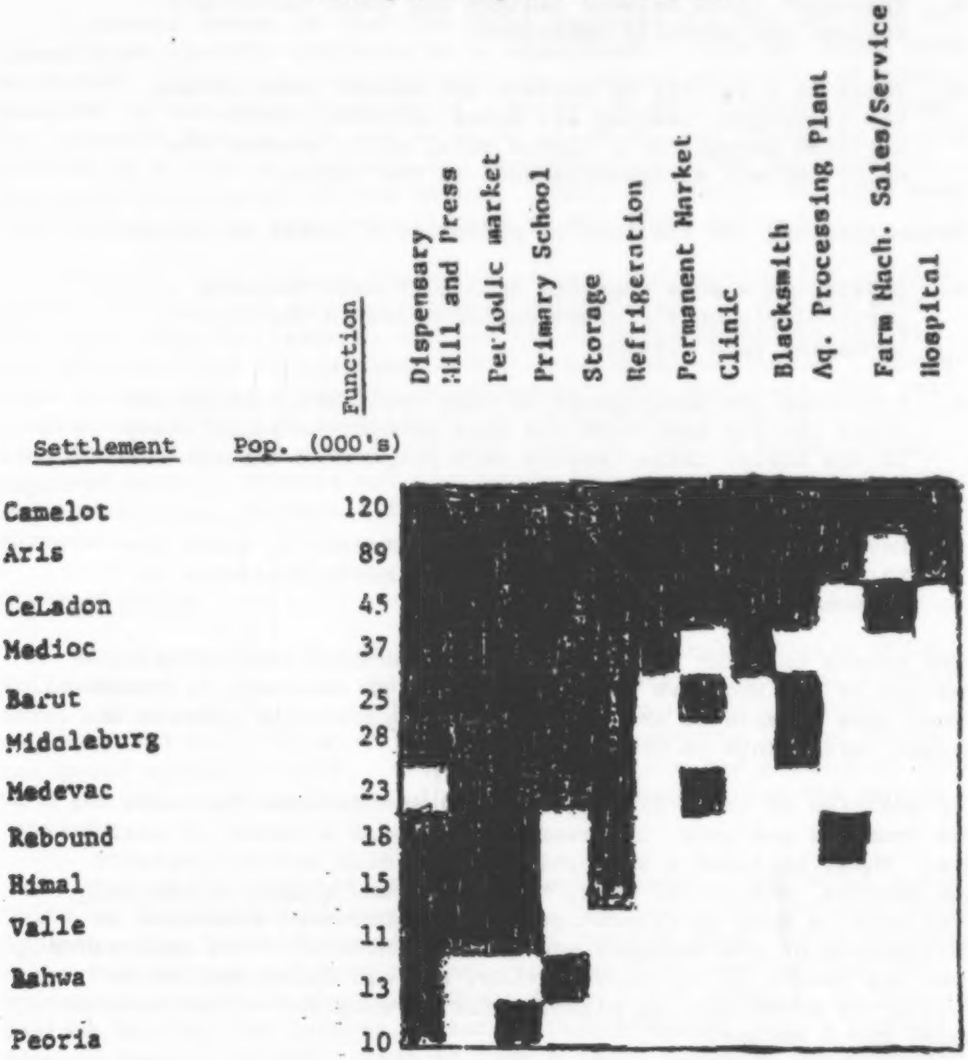
Findings and recommendations. The findings of the analysis contain a number of surprises and have significant implications for this and other river basin development schemes. It was found that:

a. The Basin is not a cohesive economic region as assumed, but rather a collection of six micro regions with little or no economic interaction among them.

b. The present boundaries of the Basin, based on purely hydrographic considerations, are not realistic from an economic development standpoint.

Figure 1

Abridged Example of Scalogram



To Construct a scalogram:

- List functions in order of frequency of occurence across horizontal axis.
- List towns on vertical axis ranked by population size.
- Fill in cells of matrix to indicate presence of service.
- Reorder ranking of towns so that greatest number of blank cells appear to right of imaginary diagonal.

Read chart to identify thresholds for services, service gaps and existence of higher order services at middle and lower levels of the hierarchy.

c. Transport links between centers and their hinterland regions are woefully deficient.

d. There is a paucity of markets and market towns within the hierarchy, leaving all areas seriously underserviced except for a narrow axial strip between the major centers at opposite ends of the region.

These findings led the team to recommend a number of actions:

a. Developing a more complete transport net, focusing particularly on the grave deficiencies in the farm-to-market road system.

b. Fostering the development of many incipient, poorly endowed centers away from the more prosperous axial strip in the Basin; these centers were pinpointed through the analysis.

c. Developing minimum packages of investments to bring the three major types of centers in the Basin hierarchy up to some minimal standard.

The extent to which these recommendations have been actually implemented is not known as of this writing; we have been informed that they have stimulated and influenced the pattern of private and commercial investments in the Basin.

In addition to these findings and recommendations that were derived from the analysis, the exercise produced a number of useful outputs. These included a statistical compendium and bibliography of data sources, analytical maps, the scalogram, a core of trained professionals, a body of literature, and an increased awareness in the Philippines of the concepts and methods involved. The approaches used now are taught in the universities, and are being applied by the Philippine government in planning for development of the remaining major river basins.

Lessons from Bicol. First, the project was data intensive and extensive; if anything, it erred on the side of collecting too much data. This was understandable since the Bicol project was the first of its kind. However, in future projects there should be far greater selectivity in data collection. For example, it would be useful to ask about each set of data collected: how will this help indicate gaps and weaknesses in the urban functions supporting rural development in the region?

A second lesson is that the Bicol analysis did not get down to identifying specific projects to be undertaken. This has since been corrected. It is now accepted that the ultimate objective of these analyses is the identification of a portfolio of projects, screened for economic feasibility and relative priority, and presented in the context of a plan or strategy for strengthening urban functions in the rural development of the region. This, of course, requires more time and resources than were alloted to the Bicol project.

Finally, even though the Bicol project did provide for participation of local and other government authorities, it did not have any input from the farmers, who are the intended beneficiaries of the project. The involvement of the local rural or "target" population in the decision process becomes especially important when the program calls for the identification of specific projects. The location, nature and mix of projects such as farm to market roads, improved market, storage and processing facilities, and agricultural credit services, to name a few, are of critical importance to the farmers.

## Other Projects

There were two companion projects to the Bicol activity which followed and in which we were able to incorporate the Bicol experience. These were projects in Upper Volta (involving two separate regions) and Bolivia (where the project is beginning in one region but could spread to six). In both projects, the end product is to be a portfolio of projects and a planning framework for the region covered.

Upper Volta project. Obviously, sub-Saharan, landlocked Upper Volta is drastically different from the tropical, archipelagic Philippines. The hierarchies of centers in the two Upper Volta regions --the Eastern and mid-West regions--are far less complex than the system of centers in the Bicol River Basin. For example, in the Eastern Region, the largest center is Fada N'Gourma with a population of roughly 14,000. Fada is like a large village. It contains a very modest market, a prefecture headquarters, regional offices of several ministries, a hospital, a secondary school, a bank and a technical training center for artisans, mechanics and craftsmen. It does not have central electricity, piped water or paved streets. This is the capital and largest city in a region of almost 50,000 square kilometers and a population of some 400,000. The mid-Western region is half the size of the Eastern region but has twice its population. The largest city is Kondougou with a population of more than 40,000. As the third largest city in the entire country, it bears the physical characteristics of a city. It has a host of functions and services and an impressive market which services a wide area. In a scalogram analysis of the regional hierarchy of centers, Kondougou was found to have 37 functions. The next largest towns in the mid-West Region, Reo (15,000) and Yako (10,000), had 12 and 10 functions respectively. Seventy-eight percent of the centers in the region had 2 or fewer functions.

It is easy to see why the project team rejected complex quantitative analyses in Upper Volta. A single scalogram and common knowledge of the two regions were used to identify the most important places. From a total of 1326 population centers, the 20 most important centers in each region were selected for intensive analyses. A descriptive profile of each of these selected centers was prepared based on field visits, interviews and a marketing study to determine the nature of local markets and the extent of their geographic coverage.

As of this writing the Voltaic project team is still preparing the final report and regional project portfolios. However, the American consultant to the project has completed his report and the findings are instructive in their considerable variance from the Philippine findings. The findings and recommendations basically were as follows:

a. There is little point in expanding the volume of services in the two regions--although additional services plainly are needed--when the first order of priority should be the repair and maintenance of existing services which presently are in deplorable condition. These services include markets, roads, culverts, schools and dispensaries.

b. A service outreach dimension should be added to existing services. This could be accomplished by providing bicycles or mobiletts to nurses, agricultural extension workers and others whose service outreach could be extended by using simple means of mobility. Similarly, the outreach of schools and rural training centers could be expanded by providing dormitory facilities in the towns in which they are located.

c. More responsibility should be given to the local level. The services system in Upper Volta is highly centralized, and the considerable capabilities at the local level represent opportunities foregone.

d. In this same context, local communities should be encouraged to levy taxes (e.g., user taxes) so that existing services can be refurbished, maintained and extended.

To initiate implementation of these recommendations the contractor has proposed that a modest demonstration program be started to restore and repair basic services in a small number of centers. These centers should be selected on the basis of both their relative importance in the region and the willingness of the local population to undertake self-taxation to continue maintenance of the services. Decisions on what projects should be undertaken should be a product of local initiative.

These recommendations obviously reflect an extremely resource-poor situation in which the main resource that really can be counted on is the people. The official final report, still in preparation, is expected to pinpoint locations in the two regions for specific follow-on activities, focussing as much on linkages up and down the urban hierarchy, like transport and marketing, as on specific town-based services. It also is expected to articulate a strategy for the spatial development of the Eastern and mid-Western regions.

The Bolivia project. The initial site for the Bolivia project is the Department of Potosi, a large, mostly highland region in Bolivia with a population of about 660,000. Much of the land area in the Department is high up in the southern altiplano region of the Andes between 12,000 and 14,000 feet in altitude, and in the high Andean valleys. Potosi is a poor region, with low per capita incomes and a poor agricultural base. It was mining, not agriculture, that originally attracted large numbers to the area. Several hundred years ago Potosi City, capital of the Department with a present population of 80,000, was the silver capital of the world and was the largest city in the Western hemisphere.

A workshop was held in Potosi in January of 1980 which introduced material from the Bicol and Upper Volta projects to all who might be interested or involved in the project. The intended final products of the project go beyond what was proposed for the Upper Volta project. The principal ones are:

a. Formulation of an Investment Framework: translation of the spatial analysis into an investment strategy which identifies projects and programs that will be needed to solve major development problems, to strengthen and articulate the regional spatial structure, and to integrate urban and rural areas within the Department.

b. *Identification of Projects*: formulation of "investment packages" for different locations within the Department, and combination of the investment packages into a priority-ranked and appropriately sequenced investment budget for the development of the Department over the next five years.

The project also calls for an *evaluation system* for monitoring implementation and impact and creation of a *continuous planning process* for spatial development of the region. The analytical steps leading leading to the "outputs" of the project include: (a) baseline analysis; (b) spatial systems analysis; (c) linkage analysis; (d) analytical mapping; (e) analysis of unintegrated and poorly served rural areas; and (f) identification of spatial and functional gaps. The Potosi Department is only one of six participating in a major rural and regional planning program in Bolivia, and it is anticipated that once the methods developed in Potosi are tested they will be adopted in the other five Departmental regional planning programs. In fact, the methodology presented for Potosi was sufficiently well received at the outset that it may be picked up by some of the other Departments even before testing in Potosi.

*Participation by the target population* was lacking in the Bicol project, as noted, although in Upper Volta it was addressed to some degree through the intensive interviewing involved in developing profiles on each of the selected centers. The need for a participation element in the Bolivia project was highlighted at the January 1980 workshop: for example, one of the Bolivian engineers asked how the analytical process outlined above could lead to "investment packages" that were reflective of needs felt by the farmers, who, after all, are the intended beneficiaries of the project. The problem is twofold: (a) how to obtain the information from the farmers and other rural residents, and (b) how to convert that information into data that could be utilized effectively by the planners. A report on this rather delicate problem was commissioned entitled, *Public Participation in Regional Development Planning: A Strategy for Popular Involvement*, by the Development Group for Alternative Policies. It identifies six basic approaches for eliciting rural input into the planning decision process, and describes the advantages and shortcomings of each. It also suggests how the information obtained through each approach may be integrated into the planning process and sets out as one option, a technique, CODINVOLV, which converts qualitative and declarative information and responses into quantitative punch card or computer data. The six approaches set out by the report as illustrative mechanisms for popular participation in regional development planning are:

a. *"One on one" approaches* --e.g., personal interviews, questionnaires, household surveys, and individual observations (for example, by a trained anthropologist).

b. *Communication with community leaders*, e.g., village chiefs, traditional leaders, and other local spokespersons.

c. *Interaction through community meetings*, specifically called meetings or public hearings--a process requiring considerable skill and sensitivity.

d. *Interaction with representative community and multi-village organizations*, e.g., church groups, women's groups, and neighborhood councils.

e. *Interaction with representative functional organizations*, probably more effective as an entry point in participation than as the final word on local views.

f. *Consultation with regional organizations*, such as regional planning and development authorities and regional corporations.

In the case of Potosi, a combination of interaction with regional level organizations and with village leaders may be the most appropriate of the approaches to apply. This remains to be determined, and plans are underway to build the participation element into the Potosi project. Whichever approaches finally are employed, the chances for success are enhanced by the fact that it was local planners who first perceived participation as a need.

On the other hand, participation in the Potosi project will be complicated by a condition which frequently confronts development planners and decision makers. Basically, the whole region is underserviced and agricultural potential is limited. Hard decisions will have to be made about which areas should be given highest priority. The choice will be between those which are poorest and have the least productive potential and those which are relatively better off and have greater potential. These are not choices that can be made through the participation process.

## Conclusion

It is too early to assess fully the impact on rural and regional development programs of strengthening the rural service functions of urban centers. However, the logic of the concept and of the methodology by which it may be applied to a field situation is gaining in acceptance even as further testing is in process. Reportedly, the approach is being applied widely in the Philippines and appears to

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have made a lasting impact on the nature of rural and regional planning. Additional field test applications of the urban-functions-in-rural-development approach with an added beneficiary-participation element are underway in Guatemala and Cameroon, and planned for Sudan. Related AID-assisted projects are at various stages of development in Kenya, Peru and the Dominican Republic. India and Taiwan also have experimented with the approach.

There is little doubt that the models of the literature have been translated successfully to field applications. Next steps will include an assessment and synthesis of the collective analytical and planning experiences, followed by a longer-term evaluation of the impacts of these projects on the progress of rural and regional development.

[Extracted from a paper delivered to the 8th PTRC Seminar on Urban and Regional Planning in Developing Countries, University of Warwick, England, July 1980.]

RED CROSS DISTRIBUTION OF FOOD
IN FAMINE AREA FOLLOWING THREE
YEARS OF SEVERE DROUGHT. (PHOTO-
FAO BY PIERRE PITTET)

# U.S. Private Voluntary Organizations Assisting Third World Development

John G. Sommer

[The term private voluntary organizations, abbreviated here to PVOs, refers to non-profit groups formed by private citizens outside government, using money that is contributed voluntarily. Such groups are found by the thousands in the United States, as in other countries, created for a great variety of purposes. Here we are concerned only with the more limited number of them who work overseas in developing countries, and whose activities serve the development of those countries in some way. Some of these organizations are based on religious groups; others are not. Some of them have very narrowly defined purposes--e.g., to provide one particular service to a limited area or group. Others may have very broad official objectives--to serve humanity, especially the ill, the hungry, etc. Whatever the official aims, we consider here what organizations actually do and where they do it--i.e., those who contribute to developmental purposes in the Third World. It must be recognized that in recent years a number of these PVOs have been working closely with governments, both in American and European overseas programs and in national government programs of developing countries. This means that some of their income may not be private. But they retain their private identity and freedom to choose what they will or will not do, with or without governmental contracts or cooperation. They would not exist without private voluntary funds, and their methods of working tend to differ from those of government agencies.

This article provides an overview of the different kinds of developmental activities undertaken by PVOs, and discusses a number of issues that have arisen in that connection.]

Private and voluntary activities in the Third World can be classified for purposes of this discussion under two main headings: relief, and development. While not all agency representatives observe a sharp

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distinction between the two types of activities, it is critical to draw one, since they focus on two fundamentally different problems. Indeed, the failure to observe the distinction has resulted in much of the frustration over aid in the past. Relief, after all, attempts to fill stop-gap needs for human survival. Development efforts, on the other hand, have--or should have--as their goal the achievement of improved standards of living, (defined on a variety of planes) and the capability to be self-sustaining into the future. There are borderline cases where short-term relief programs may pave the way for longer-term developmental efforts, but too often this transition is not made.

The voluntary agency trend is now to emphasize development as much as relief, based on a growing recognition that if solutions can be found for the root causes of poverty, then ultimately one can break out of its "bottomless pit" and, among other things, be better able to cope with disasters as well. Yet there is still a certain ambivalence in agency programming, an ambivalence that derives partly from pragmatic perceptions of diverse needs and partly from the conflicting signals given by different types of donors. Human nature being what it is, the movement toward "development" is inevitably influenced by the lure of the dollar. In general it has always been easier to obtain private individual contributions for relief after well publicized disasters than for less dramatic, longer-term endeavors. Among some outside funding agencies, however, most notably the U.S. Agency for International Development since 1973, there is currently a clear emphasis on supporting PVO programs aiming for long-term development results. The American public, on the other hand, has barely begun to make the transition to understanding the longer-range complexities of development, although it responds most generously to emotional relief appeals. Agencies must understandably maximize income, and this encourages them to be as ambiguous as possible about their goals and ideologies. Ambiguity increases the number of contributors to whom agencies may appeal; it is therefore a rational strategy for fund-raising agencies to 'becloud their policies in a fog of ambiguity.' It is this dichotomy that may partially explain the curious mix of programs that emphasize both visible short-term and less visible long-term goals to please both types of supporters. At the same time, the tendency to blur relief and development may lie in a failure within the organizations themselves--their boards and executive ranks--to comprehend fully or agree on what is meant by "development."

For purposes of discussion, and notwithstanding considerable overlapping, one can group most efforts of private and voluntary organizations in development under three headings: development of physical and income-generating infrastructure; development of institutions; and development of human resources. The first type of effort refers both to the building of physical infrastructure such as roads, irrigation works, and industrial installations, and to providing other types of production-oriented inputs such as seeds, pumps, and fertilizers that directly or indirectly give people their livelihood and sustenance.

## Physical and Income-Generating Infrastructure

Many private and voluntary organizations have contributed, and continue to contribute, to physical infrastructure development in the Third World. A study of aid to Brazil noted that "more than half of the aid of private bodies goes for schools and hospitals...[and] that construction and equipment absorb almost half of the aid... This could well be an indication that the criteria are often palliative or [reflect] the desire to achieve visible results that can give satisfaction to the contributor." The question, indeed, is whether those efforts to create physical infrastructure are both income-generating and equity-promoting over the long run. Not surprisingly, the largest contributions on the physical side have come from the largest agencies, such as CARE. These efforts have made extensive use of U.S. government food resources to feed workers who are organized to build up physical infrastructure.

Physical infrastructure tends to be popular with private organizations, as it is with government and multilateral aid organizations, for three reasons. First, as suggested by the Brazilian example, the end product is highly visible, thus demonstrating to those who have contributed the resources what they have accomplished (and making them happy to contribute and build more). Second, physical infrastructure is relatively easy and straightforward; one has only to design what is needed and hire people to build it. "Self-help" programs are a more imaginative variation here, involving the local population assisting the construction on a voluntary basis, thus helping to ensure their continuing interest, maintenance support, and--theoretically--further participation in improving their own lives thereafter. On the other hand, the local initiative involved in such programs is sometimes exaggerated, with the effect occasionally being one of simply getting a job done with cheap labor. There is also a third and more culture-bound reason for the popularity of physical infrastructure projects, namely that because communities in the West have developed infrastructures, there is assumed to be an obvious need for physical facilities everywhere. The danger lies in the Western assumption--often misleading--that a village without a school or hospital automatically needs a school or hospital. Some efforts that contribute through physical infrastructure could be counterproductive to more favorable development goals by displacing other less visible activities.

Health. A case in point in the field of health is exemplified by a young and talented Bengali doctor who, unlike the majority of his more profit-oriented peers, was committed to improving health care for the people of a rural area not far from Dacca, the capital of Bangladesh. Realizing that any program, to be viable over the long term would require its own self-financing mechanism, he devised a medical insurance scheme inexpensive enough for the villagers to afford, yet sufficient to cover at least part of the recurrent costs of the medical services offered. Realizing, too, that local involvement was necessary in order not only for this particular scheme to succeed but also for the people to begin to enjoy some of the fruits of broader developmental processes, he engaged some thirty-five committed auxiliary health workers to interact intensively with the villagers. Their main task was not only to cure diseases but also to convey information and guidance on preventive medicine--for example, the need for sanitary drinking water and food handling, and for improving the nutritional value of their diets--as well as family planning. Because gastrointestinal maladies accounted for a major share of the illnesses in that area, the need for scarce capital-intensive hospital facilities could be reduced by following such labor-intensive paramedical practices in the villages themselves. However, the doctor's initial mistake, as he himself observed in a candid moment, was to allow his own ego, and that of the foreign voluntary agency supporting him, to permit the construction of a relatively large central hospital building, the grand design of which was in obvious contrast to the simpler local setting. As the building was going up, he observed for a time a decreasing sense of motivation among his staff members to mingle with the poor; in the early months they had been enthused by the challenge of their rural development role, but they then became increasingly spoiled, he felt, by the rich impression created by the new hospital building.

This situation and others similar to it indicate that, although poor working conditions can also discourage staff and lower morale, one of the problems of overfinanced infrastructure is that its ostentatious image (not to mention its subsequent maintenance costs) may conflict directly with the values one wants to encourage--or that are otherwise more realistic--in very poor settings. In other situations, however, buildings can have positive psychological effects; and in any case they have their normal utility. Many areas, for example, continue to rely on the services of missionary hospitals.

Agriculture. Because there are only a few voluntary organizations that have sufficient resources to build many schools, hospitals, feeder roads, bridges, or irrigation facilities, their major contributions to physical and income-generating infrastructure tend to be in the area of small- to medium-scale agricultural development. The classic example is what has become known as the Green Revolution. In the 1960s, new high-yielding varieties of wheat and rice that have the potential for multiplying crop yields were introduced into a number of countries. Because the new seed varieties require more fertilizer and more careful regulation of other inputs, especially irrigation water, they have been criticized for being more helpful to rich farmers than to poor farmers because the latter are less able to afford these inputs; also, poor farmers may lack both the knowledge base required to utilize the new technology and the risk-taking capability to try it out.

On the other hand, many observers feel that the poor, with their small plots, can profit more from Green Revolution technology than can the rich, with their large plots, because of the former's greater practice of the more intensive cultivation required by higher-yielding varieties. It is here, in fact, that the voluntary organizations have made particular contributions in spanning the information, technology, and input gaps to the otherwise ignored poor farmers. International Voluntary Services and the Mennonite Central Committee with their agricultural technicians; Oxfam-America through its small but strategic grants of seeds and well equipment, and its institutional support; and World Neighbors and a whole host of church and secular organizations assist in promoting these new technologies. They assist in the production not only of wheat and rice, but also of soybeans, vegetables, and other nutritious dietary supplements previously either unknown in particular settings or infeasible until faster-growing wheat and rice varieties permitted multiple cropping patterns and thus more efficient use of land. World Neighbors, for example, reported in 1970 that in one cooperative project with a Gandhian group in South India, "the output of vegetable foods...gave an increase of 6,050,000 pounds or an average per capita increased availability of vegetable foods of 60.5 pounds. There was also an increase of 650 grams per person in animal foodstuff, largely from eggs and poultry." For every dollar invested by World Neighbors, this amounted to an annual food value of $43 for local consumption.

A linkage between relief and development programs is readily apparent in the PVO response to the widespread droughts of the mid-1960s and 1970s in South Asia and Sahelian Africa, which served to mobilize efforts in agricultural infrastructure. There have been cycles of fat and lean years throughout history; now it appeared that the vulnerability of whole populations to climatic vicissitudes could be eased by invoking the new technologies and the affluence of the West to deal with the root problems of food scarcity. It thus became a logical extension of relief feeding efforts to dig wells, construct water channels, contribute pumps, and train local people in the potential of agricultural advance. Church World Service, Lutheran World Relief, Catholic Relief Services, Africare, CARE, Community Development Foundation, their local counterpart organizations (particularly among the churches), and many others--including European and Canadian voluntary organizations--found themselves contributing.

The problem, again, is how to make sure that this assistance really helps the poor majorities in the Third World. Poor farmers lack risk capital to attempt new cropping methods or livestock breeds. The geography of irrigation and drainage flows does not necessarily coincide with equity considerations in the sense that a dam needed to control the flow of water to both rich and poor farmers may have to be placed for reasons of nature near the rich farmer's field, which tends to give him control through easier access. Organizations attempting to introduce improved breeds of animals will naturally have more confidence in the most "reliable" farmers with a reputation for being able to care for them well; this is understandable since everyone loses if the animals fall into the hands of untrained farmers unable to ensure their survival and reproduction. Poor farmers usually have no proven track record. This is why Heifer Project schemes, for example, insist that the initial, better-off beneficiaries repay their original animal grants to poorer, higher-risk farmers by giving them the offspring as they are born. Otherwise the poor would be left still further behind.

Handicrafts and light industry. In many areas, private and voluntary efforts are directed to the encouragement of employment-generating small enterprises for handicrafts and light industries, as well as various commercial and service trades. In Kenya, the U.S. and European church-supported National Christian Council trains and sponsors handicraft artisans; their products find a ready outlet through the tourist trade. Partnership for Productivity is helping with the managerial training required in introducing people to a variety of small business ventures in western Kenya. In Honduras, Technoserve has assisted in the establishment of carpentry shops in which the country's timber-growing advantages are exploited to make wooden products for export. The Community Development Foundation assisted a group of Honduran women in purchasing a corn-grinding mill to enable increases in their production of biscuits. And in Bangladesh, the Christian Organization for Relief and Rehabilitation, the Mennonite Central Committee, and Oxfam cooperated to establish the Jute Works, an organization committed to enabling women--initially widows of the Bangladesh liberation war--to achieve self-sufficiency through the fabrication of jute handicrafts. By 1976 the Jute Works had an annual turnover of $500,000.

## Development of Institutions

Less tangible than physical infrastructure, but at least as important to development, is the institutional context of planning, decision-making, and implementation of change-oriented policies. U.S. private and voluntary organizations--along with the international aid establishment generally--have been active at several levels in both building and opening up institutions to give the poor greater access to planning and management resources. The foundations and university groups frequently help at the higher up or "apex levels" of the government or the education sector, and the smaller voluntary organizations tend to help closer to the grass-roots level.

Planning institutions. A major "apex level" activity of the foundations and universities has been the assistance given to national planning commissions in a number of Third World countries, notably in Asia. For newly independent nations short of both material and managerial resources, the need for careful planning and allocation of those limited resources is crucial. Colonial administrations, concerned with political control and commerce, were not organized for this kind of development planning. Thus, for example, the Ford Foundation financed advisory teams from Harvard University to help Indonesia and Pakistan, among other countries, become involved in these countries at different levels of national agricultural, educational, and management planning under either foundation or U.S. government funding. While generalizations are risky, it can safely be said that these efforts succeeded in their goals of institution building to the extent that they were able to recruit competent and culturally sensitive American or European advisors, and the setting afforded minimal local political and bureaucratic impediments.

Events often take unexpected turns. In Indonesia, highly intensive foundation-funded and university-conducted efforts to train entire economics faculties served unexpected purposes when the Sukarno regime was overthrown in 1965/66 and replaced by General Suharto's more technocratically oriented government, which drafted the U.S.-trained economists to high government-planning posts. While the universities may have suffered, Indonesia's national economy improved dramatically under the tutelage of these economists. In Pakistan, the Ford Foundation funded high-level and competent U.S. academic assistance to the government's planning group. Political and bureaucratic priority was attached to many of the group's recommendations, and the country's gross national product rose encouragingly. Yet there, too, events took an unforseen course. First, in 1968, the Ayub government toppled, due in some part to discontent over the unevenness of economic progress; and in 1971 Bangladesh went its separate way, in part because it had been a neglected region. The Harvard advisory team, though perhaps as concerned as the Pakistani government had been with equity considerations, was charged in its planning with a lack of sufficient sensitivity to either Bengali or poverty-group needs; and the Ford Foundation was jolted into undertaking in 1969 an introspective post-mortem of its role in assisting those planning efforts.

Research institutions. If policymaking is partially based on political judgments and realities, it must also draw on knowledge derived from research. U.S. private assistance groups have made major contributions here too. They have supported academic institutions and field-oriented institutions on the principle that Third World decision making should be based, at least in the long run, on Third World research.

Agriculture is a good case in point. While voluntary organizations have been instrumental in spreading Green Revolution technology among the poor farmers, the foundations--principally Rockefeller and Ford--are responsible for establishing and funding the centralized research institutes that developed the new technology initially. In fact, there are now nearly a dozen such institutes linked together for support through the Consultative Group on International Agricultural Research, which operates under the auspices of the World Bank, Food and Agriculture Organization, and U.N. Development Programme. Their research covers a wide range of products and local conditions, including crops such as wheat, rice, various tropical agricultural products, coarse grains (millet and sorghum, for example), and potatoes. If one adds in the research institutes' country-level affiliates in a number of Third World nations and considers the amount of new food production resulting from the new technology, the network has proven to be an immensely significant one that represents perhaps the greatest single contribution of the private nonprofit sector to world agricultural development.

Broad-based community development institutions. Community development theorists and practitioners have long held that broad-based participation on the part of all segments of a local community is necessary if equitable development is to occur. One form of institution building in the Third World that is directed to these goals is represented by U.S. cooperatives. The zeal that has gone into spreading cooperative structures for housing, rural electrification, small enterprises, credit unions, and so on often appears at least as intense as the zeal that infuses religious missionaries. Because cooperatives have been successful and influential forms of social and economic organization in parts of Europe and the United States, they have had considerable political support in the U.S. Congress and in U.S. AID, and are seen by many, like physical infrastructure, to be essential to development in the Third World. Indeed, co-ops have succeeded in a number of Third World settings, particularly in parts of Latin America and Asia. Some other societies, particularly in their more traditional sectors, are culturally less receptive to the Western style of cooperatives. Village-level co-ops, not surprisingly, work best where social and cultural homogeneity is greatest. The fact that inequity rather than homogeneity is characteristic of many Third World societies makes the co-ops, like other forms of organization, susceptible to manipulation of the poor and impotent by the rich and empowered.

One of the more interesting models for promoting development is that employed by some private groups in the field of credit in Latin America. Because the credit gap is one of the major constraints to development in a number of Latin American settings, a variety of outside assistance agencies, both governmental and private, have attempted to help in that area. Yet worldwide experience has shown that credit in the absence of necessary technical assistance and overall supervision is either insufficient or, where it profits the wrong people, counterproductive. Thus, both the Pan American Development Foundation and the U.S. Credit Union National Association (CUNA) have assisted in the formation of associations throughout the continent that dispense not only credit but also technical and supervisory support to local cooperatives and other groups. As a result, no doubt, of their approach, their loan repayment rates are very high, in sharp contrast to the repayment rates of governmental and other lending institutions offering fewer support functions. In Honduras, for example, the private co-op repayment rate was about 88 to 90 percent in 1975, and the government co-op rate was about 65 percent. The Honduras case is of interest in another sense in that at least one major private credit organization has been a member of a larger institutional grouping called CONCORDE, the other members of which are engaged in education (including the influential radio schools), technical assistance, and various types of community development activity. Through the joint programming that is thus possible, the impact of the individual component inputs is magnified.

Another attempt to institutionalize participatory development at local levels is reflected in the methodology of the Community Development Foundation (CDF), also known (mainly for fund-raising purposes) as the Save the Children Federation. CDF insists that the inputs it provides and the activities it supports must be governed by a committee on which all local groups are represented--rich and poor, powerful and powerless, men and women, and whatever variety of castes and religious groups may be present in the particular area. Theoretically, this could have a significant impact in many situations, for traditional societies are often not known for their democratic "one person, one vote" modes of governance or for representation of all groups in the governing process. In practice, therefore, such efforts are fraught with difficulties. For example, it is not clear, if an issue arises in which the local committee and CDF representatives have differing views, that the committee will always prevail; nor is it clear that broadbased decision-making would be applied more generally to non-CDF funded activities that would continue into the future. The point is that local traditions and patterns of organization tend to be strong; transitory outside projectizing, no matter how well funded, is usually unable to force permanent change of this nature without traditionalist reinforcement.

A further example of efforts to institutionalize increased participation can be seen in the growing number of programs currently being promoted by some private and voluntary organizations, including CDF, to enhance women's roles in development. Development planners in the host countries have not always taken this new concern seriously, considering it to be an export of a Western movement that has little application to their societies. Yet the women's movement has developed its own manifestations in the Third World, and increasingly, groups of Third World women are exerting pressure on their governments to respond to their needs and action priorities.

Churches. Among the major institution builders overseas are the churches. Aside from their efforts to build local church groups, they have traditionally been very active in creating hospitals and schools. Indeed, they were in some areas the original institution builders, responsible for establishing the schools and colleges that trained many of today's most prominent Third World leaders. Today the major Catholic and Protestant denominations are increasingly channeling their support to the Third World through their local religious affiliates, partly in recognition of the substantive desirability and long-term efficiency of such an effort, and partly in view of the political sensitivities toward outside religious groups on the part of many Third World governments. Thus Catholic Relief Services, like the worldwide Catholic hierarchy, has given priority to building up the capabilities of Caritas or other local Catholic assistance organizations in countries where CRS works; and the (Protestant) Church World Service, like the World Council of Churches network as a whole, has assisted the various national Christian councils of Asian, African, and Latin American countries. CWS, at the same time, has moved increasingly from an emphasis on projects or programs to one on the quality of interpersonal and interinstitutional relationships, simultaneously increasing the size of its own international (as opposed to U.S.) staff and the range of its multilateral approaches. Much the same has been true of the smaller Quaker and Mennonite bodies.

In the preceding pages, examples of some of the PVOs' major institution-building efforts have been described. But there are also dozens more that could be cited: the various national volunteer corps for student and youth involvement in the Third World which were given a significant impetus by the U.S. Peace Corps; the Peace Corps itself, which was substantially modeled after the earlier volunteer-sending programs of the International Voluntary Services and the American Friends Service Committee; the YMCA and YWCA movements, which involve young people in group activities, sports, and training programs; the 4-H Clubs for rural youth leadership development; the Salvation Army; the Red Cross, which began in Europe in the nineteenth century and soon became an important international movement, institutionalized in the form of national organizations in nearly every country of the world; the Boy Scouts and Girl Scouts, which began in the United Kingdom with Lord Baden Powell and which, with both colonial European and U.S. encouragement, extended throughout the Third World; a variety of U.S. and European child adoption and other welfare agencies; and CARE and Catholic Relief Services (cited earlier), which played both initiating and exemplary roles in the institutionalization of social welfare functions both in governments and in the voluntary sectors of Third World countries.

U.S. and European private and voluntary organizations have done much to encourage appropriate adaptations of indigenous institutions for welfare to current realities. The institutions they have supported have sometimes had largely palliative effects, but other times have contributed to broader changes in favor of greater equality of opportunity for the poor. The analytical problem is that the positive and negative results of institution building--particularly insofar as they abet access and equality of opportunity for the poor--are far harder to assess than those of physical infrastructure. Still harder to assess are the results of human resource development.

## Development of Human Resources

While virtually any developmental activity affects human resources, those that place primary emphasis on their improvement are considered here. The gamut is broad, ranging from social welfare and child adoption schemes at one extreme, through education, to "consciousness raising" leading to the possibility of more radical change at the other. In between lie people-to-people volunteer efforts, scholarship programs, skill-training efforts, "technical assistance," and, of course, the religious efforts of the missionaries.

Social welfare. The most straightforward way to affect human resources is through direct gifts and provision of services to poor people. The child sponsorship agencies, such as Christian Children's Fund and Foster Parents Plan, are typical here in that they raise money from U.S. "foster parents" and convey it (after covering administrative expenses) to a particular child in the Third World. The voluntary organization is thus providing a brokerage service between two individuals who then exchange letters periodically to enliven this mutual involvement. Partly because the notion of pure handouts and their implied paternalism have come under increasing attack, both in the West and in the Third World, the child sponsorship agencies are increasingly applying portions of the donor gifts to service programs benefiting not only the child but the larger family and community as well. Foster Parents Plan in Colombia, for example, divides the $16 contributed monthly by each parent by giving $5 directly to the child, applying $6 to community services such as education and health, and leaving approximately $5 for administrative expenses. In this way the organization is better able to ensure that at least some of the funds are utilized for the general well-being of the child and family, perhaps in ways that improve their long-term development outlooks. On the other hand, the child sponsorship agencies still justify their direct handouts--the monthly grants plus special holiday gifts frequently sent by the foster parents--as increasing the participation of recipient families in their own development. Indeed, they argue, it is in some ways better to give cash, for it can be spent according to the families' own priorities rather than in accordance with some one who decides from outside what is best for them.

Another example of the social welfare approach to human resource development is that of the Salvation Army and the variety of schools, daycare centers, and programs for the aged and handicapped conducted by them and by a number of other religious groups. In Kenya, for example, the Salvation Army has established literacy and homemaking centers for teenaged girls, training in farming and bee-keeping, and vocational workshops in schools for the crippled and blind (the Salvation Army being the first in Kenya to assist in the latter area). Many other religious and non-religious groups have assisted in similar efforts in some of the most remote parts of the world. Of course, some observers would say that these are not developmental activities, because most are dependent on continuing foreign funding, generally on the foreigners' terms. At a different level, however, these activities are encouraging the development of a generation of people who could, in turn, affect general community advancement in the long run. This suggests, therefore, that one should judge the developmental effects of such efforts as much by their impact on *people* as by their impact on *institutions*, as long as dependencies on unsustainable outside funding sources are avoided.

The hallmark of the private and voluntary organizations has been their ability to concentrate on the more human aspects of development. Founded on the notion of people-to-people assistance--this element primarily distinguishes their efforts from governmental ones--their typically small size, humanitarian motivations, and overall ethos combine to reinforce the personal approach. Even though a negative reaction to the too-fuzzy humanity of the past has begun to lead some organizations to more technocratic and bureaucratized approaches today, such organizations still tend to have advantages over large official and multilateral efforts.

Training and technical assistance. One of the most useful contributions of private organizations has been the provision of fellowships for study abroad, enabling thousands of Third World nationals to learn the skills necessary for managing modern economies and technologies. The endowed foundations have been particularly active in this arena, not only in funding students but also in sponsoring joint research efforts, conferences, and other forums where Third World people can come together with each other and with their peers from the West. Of course, not all aspects of this coming together are positive for development; training in the West has come under fire for tending to alienate the trainees from the realities of their own national situations when they return, or their failure to return home after training. Many people have also criticized the Western exportation of the "jet-set scholar" phenomenon. In an interdependent world, however, sharing must be presumed better than not sharing, the vital point being the need to ensure equitable sharing of opportunities for knowledge both within societies and across national boundaries.

Partly because of the brain-drain problem--the non-return of trainees from abroad--but also because much of the overseas training has proven less than relevant to location-specific Third World needs, private assistance efforts are increasingly focusing on training conducted within the individual country itself or in analogous Third World settings. The Ford Foundation, for example, has moved very substantially in the direction of funding Asians to study in Asia, Latin Americans in Latin America, and so on. This permits grappling with local problems in "field" situations and with peers who have had experience in solving them. In a period of tighter funding for such programs, it also means that each dollar spent will go farther, given the lower transportation and living costs involved. The transition is not an easy one; Sri Lankans accustomed to the glamor of a British university experience find that studying in neighboring Indian institutions provides a less prestigious credential upon their return home. Some, of course, see the logic, especially as certain Third World institutions have gained sufficiently in competence and prestige to serve as regional resources. An extension of this trend is for short-term training to be conducted by Western technical specialists in the particular Third World country itself. While numerous trade-offs are involved in deciding whether to provide training by exporting students or by importing experts, increasingly the preference is for local training, which can have a broader impact by exposing more people to foreign specialists while at the same time ensuring relevance to a specific Third World country's conditions.

"Technical assistance" is a term that has been used almost interchangeably with "development assistance" for voluntary agency efforts (and also for organizations like the Peace Corps). It describes much of the rationale behind several volunteer-sending organization: International Voluntary Services and the Mennonite Central Committee, with their technical agriculture and public health specialists; some of the cooperative organizations, with their specialists in credit and co-op management; some of the member organizations of PACT, with their small enterprise backgrounds; and most pertinently for VITA, which serves as a source of information on increasingly popular village technologies for Third World development organizations. The purpose of technical assistance is to transfer improved techniques of agriculture, public health, education, nutrition, and management to people in the Third World. In recent years, increasing attention has been given to structuring these transfers to increase the certainty that those trained, or exposed to the techniques as recipient-country "counterparts" will fill critical roles in their countries' development efforts, thus multiplying the initial contribution of the foreign volunteer. This has happened to an impressive extent in many places; yet technical skills are not being transferred in a vacuum, and political, administrative, and larger economic imperatives still play the largest roles in affecting the fates of individual technical assistance efforts.

Consciousness raising. In some kinds of situation, foreign voluntary organizations are confronted with a choice between providing palliatives within an "unjust" system or trying to change that system. The concept of consciousness raising finds its most articulate expression in the writings of the Brazilian educator, Paulo Freire. Freire's experience with people in northeast Brazil led him to the observation that people are exploited or otherwise fail to realize their full human potential because they are not aware of their situations, of the factors that cause them to be as they are, and of their potential options for self-improvement and self-actualization. Thus he advocates an educational method that would enable people to change such structures through a "critical consciousness raising" process that leads to "appropriate actions." Traditional forms of learning are of no use unless people can apply what is being taught to their daily lives and to ways of improving them. Traditional extension programs and other developmental activities may be similarly useless, even if they are focused on helping the poor, if the poor do not know how to internalize their meaning in order to take optimum advantage of them. Because Freire insisted on a methodology that would not explicitly incite rebellion--after all, this would be tantamount to using poor people as fodder for someone else's revolution--his notion of consciousness raising calls for a subtle self-questioning process by which alternative courses of society and action can be explored. It is essential to his methodology that the search for solutions be initiated from within the group so that the group determines its own actions with all the dignity that such internalized responsibility implies. Indeed, it is this element that distinguishes the consciousness raising approach from the more traditional forms of community development in which many voluntary organizations have been involved over the years.

The consciousness-raising approach is coming to the fore in some development strategies discussions, and practical applications are being attempted in Tanzania, Guinea-Bissau, Thailand, Bangladesh, and India, as well as in Latin America and no doubt in other places. Many consciousness-raising efforts in Latin America--indeed, most of the nonunion, nonparty development activities--have been initiated by the Catholic church. While the theoretical virtues of the approach seem clear, its relatively recent application as well as the difficulties inherent in its implementation have meant a paucity of current evidence as to its effectiveness in actually enhancing the possibilities for improving people's lives.

Cultural awareness, as an intrinsic part of consciousness raising in the sense that an image of one's individual and community identity is a necessary prelude to sound development, is an area in which some PVO activities are in evidence. The JDR III Fund, the Asia Foundation, the Ford Foundation, and Obor have recognized the importance of local cultural expression as a concomitant of development, each pursuing articulated needs in its own individual way. John D. Rockefeller's JDR III Fund was a pioneer in offering support for the preservation and development of Asian arts. The Asia Foundation, which funds a variety of training activities, has been especially innovative in its support for training Buddhist monks in Thailand to become involved in local development activities in ways culturally relevant to the strongly Buddhist traditions of that country and its people. The Ford Foundation's overseas cultural involvement has been recent; although its support of archeological and arts activities constitutes only a small share of its overall budget, that support is significant in symbolizing the recognition that there is more to development than economic indicators alone. Obor, a small organization run on a shoestring budget, is dedicated to the publishing of books in the Indonesian language in order to encourage indigenous discussion of development topics that were earlier the exclusive province of the foreign-language-speaking elite.

## Measuring Success and Failure

Were development an end product rather than a process, it might be relatively easy to evaluate programs aimed at its achievement. One could decide on certain attributes--cash income, literacy, caloric intake, mortality rate, days lost to work through illness, or whatever--and conclude whether one's "development" efforts had succeeded in measurable statistical terms. The measuring could be done on national, provincial, district, community, and even individual family levels. There would always be a problem of separating the foreign aid influence on any given situation, but one could presumably cope with this problem through analysis and common sense.

Development, however, is not so much an end product as it is an historical process. Grappling with far more than the amelioration of poverty, it involves the very essence of the whole person with his self-reliance, sense of dignity, and culturally defined spiritual attributes. It is nearly impossible to evaluate success on these exalted planes other than through highly subjective, sensitive interactions with the local group that is being aided. However, it is useful to survey how various types of private and voluntary organizations have grappled with the effectiveness question--a question of concern not only to individuals involved in the development process but also, increasingly, to the funding agencies that choose whether or not to support the voluntary organizations.

Until the past few years, everyone talked about evaluation, but few did anything about it. It was widely felt that the private humanitarian agencies, many of church origin, were effective simply because they were "doing good;" missionaries were acting as witnesses to God's works on earth, and they interacted with the poor; these were good ends in themselves. Their relief and rehabilitation programs distributed goods from the rich to the poor; this could hardly be anything but laudable. Their motivations, too, seemed pure. What more was there, then, to evaluate? As times and standards changed, doubts increased--doubts fostered by widening gaps between rich and poor; by disillusionment within the United States that aid to the Third World was not having the same effect as it had had in Europe; by a growing recognition of the existence of poverty and injustice at home in the U.S., as illustrated by the civil rights movement; by the decline in overt cold war competition; and by all the basic reassessments of American values, identities, and interests that these developments helped spawn. Simultaneously, increasing concern was being expressed within the Third World countries--concern that having shed their colonial chains, they still found themselves affected by new manifestations of Western paternalism, including those inherent in the classical aid relationships. This considerable flux in the self-perceptions of both sides is leading to new ways of assessing successes and failures, and to new modes of joint action in the future.

All this is not to say that a number of organizations had not, in their own ways, already been giving attention to assessing grant and activity performance. Yet it is fair to state that for the majority of organizations, especially those receiving U.S. government funds, it was the 1973 Foreign Assistance Act that spurred what has now become a real trend toward more regular evaluation. The 1973 foreign aid bill provided a clear mandate to the U.S. Agency for International Development to channel more of its funds through private and voluntary organizations. The congressional debate made it clear that support for official aid, having already significantly declined, would decline further, or even disappear, unless it could be shown that poor people rather than rich elites and military causes were benefiting from it. By 1974, therefore, AID was propagating the virtues of the logical framework matrix (the "logframe") as a methodology for impelling proper planning and evaluation of foreign assistance projects. (See Development Digest, July 1979, pp. 71 and 80; see also p. 105 for a proposed method of evaluating PVO projects.)

At the time it was introduced, the logframe appeared to represent everything the majority of voluntary agencies did not; scientific exactitude in a world of amorphous human imponderables, and the triumph of statistics and computers over what were seen as fuzzyheaded do-gooder mentalities. Many voluntary organization staff members, resentful of any dependence on U.S. government financing, were further offended by the U.S. government's making that financing dependent on their adoption of the logframe methodology. Many felt that this overly quantitative approach failed to recognize the human elements in their programming. On the other hand, some appreciated the logframe as a device to focus their thinking about projects in a more orderly way; for these groups the device proved useful. Whatever their reaction to it, the logframe did challenge the voluntary agencies to think of their programs in a different light than before.

In 1975, a group of leading voluntary organization executives convened under the auspices of the Overseas Development Council to define the most critical issues they foresaw for their programs over the coming years and decades. One of the critical issues they agreed on was the need for some framework within which they would be willing to be judged by themselves and by others, and they thus attempted to evolve a set of relevant program criteria. The criteria they agreed on, while expressed in generalized terms, address the issues of dignity and self-reliance, and could have extremely far-reaching and constructive program implications if really implemented. For example, recognizing the problem of lack of continuity in their efforts, the participants noted that a local group must be able to sustain and improve on any PVO development activity after an outside agency's help is withdrawn. Hearing their efforts criticized for having the effect of fostering the status quo, in which the rich dominate the poor, they stated that their programs should result in increasing--or at the very least not diminishing--the power of a poverty group within its own local or national system. Furthermore, "the local group must be as aware as the PVO of the political, cultural, and economic implications" and risks of embarking on any given program. In response to the frequent complaints of paternalism, the participants agreed that "the power of the local group vis-a-vis the PVO should grow during the course of the program," and that "the PVO should make itself actively accountable to the local group, sharing power over the program with that group." Indeed, they agreed, it must be the local group that defines its own needs in the first place, and that then has the major responsibility to decide with the PVO the terms and conditions of the program. To minimize the dangers of overly ethnocentric Western approaches, "the PVO should work in a manner that respects the primacy of local cultural values, while at the same time not violating its own cultural standards... The PVO must openly state to the local group its own motivation, goals, and evaluation criteria for the program...[and] evaluations should be made, or at the least shared, with local groups."

This emphasis on the critical primacy of the local group over the foreign voluntary organization raises the related question--answered by the voluntary agency executives only in general terms--of who evaluates the programs. To date, the issue has been primarily one of agency insiders versus outsiders. Africare, for example, in order to ensure objectivity of results, insists that only outsiders should assess its programs. Other organizations insist that only insiders conduct evaluations. They fear that outsiders may be biased by their own preconceived notions or by unfamiliarity with all the elements that went into the program's history; or they feel that if evaluation is to be useful for future programming decisions, it should be an internal process to ensure that the lessons are learned and internalized by those with a proprietary interest in the process for the future. Still other organizations set up assessment teams comprised of both insiders and outsiders.

PVOs and the role of evaluation: two cases. One of the most exemplary evaluations of a voluntary organization program--remarkable both for its thorough methodology and its revealing conclusions--is that of the American Friends Service Committee's Barpali multipurpose village development project in the State of Orissa in India. The AFSC had sponsored this project from 1952 to 1962; in 1971 one of the American participants returned to the scene to study what results were evident nearly ten years later. No other organization is known to have taken this detailed a retrospective look at its earlier village efforts. Through interviews with several local project staff members, as well as with local government and other officials, it became clear that lasting changes in agriculture and health had come to Barpali through the AFSC involvement. But the feature of the program that seemed to be best remembered was the AFSC confidence in the local people's ability to help themselves. "They did not give gratis or charity. Instead of doling out, BVS (Barpali Village Service) extended a helping hand... The most important feature of BVS was a sincerity of purpose which was lacking in Government programs whose only purpose was to spend money allocated for a project... Mixing with the people was the most important feature of BVS... The project helped people to become self-sufficient." Significantly, the main criticism seemed to be that the AFSC project should have continued longer; ten years was long enough to teach about the need for new agricultural and sanitary practices, for example, but not long enough to bring about all the changes required. The self-help approach was foreign to local customs, which had been shaped by caste hierarchies and colonial structures. Since the new approach was not subsequently emphasized by government development programs, villagers gradually reverted to their old roles after the AFSC departure. This negative turn of events was countered only to the extent that former project associates who later went to work for the local government were considered more effective workers because of their earlier experience.

It may be helpful to look at a second case--that of World Education--to illustrate the benefits of evaluation and particularly of examining development programs in their larger environmental contexts over time. World Education, like many of the more creative U.S. voluntary organizations, grew out of the vision of an extraordinary person--in this case an American dowager, Mrs. Welthy Fisher, who decided at an advanced age to take up the cause of increasing literacy in India. Throwing herself whole-heartedly into the cause, Dr. Fisher raised enough money to create in Lucknow an institution called Literacy House. Literacy House grew and thrived and soon became India's principal center for developing innovative educational curricula and instructional materials for teaching functional literacy outside the constraints of the traditional classrooms of the formal school system. While the formal system was placing emphasis on literacy for literacy's sake, the new voluntary institution saw literacy primarily as a tool for people to improve their everyday lives through access to written materials on better hygiene, nutrition, agriculture, animal husbandry, and family planning. While the formal system relied primarily on rote teaching, Literacy House developed methods of teaching through the use of puppets; this attracted village audiences and held them spellbound, thus increasing the likelihood of the multiple educational messages sinking in. The curricular and instructional materials developed by Literacy House, with assistance from Dr. Fisher's U.S.-based World Education organization, were soon being used for ad hoc nonformal education efforts in many parts of India, and were translated into languages besides the Hindi of the Gangetic plain. To be sure, there has been no institutional way to propagate the instructional methodologies pioneered by Literacy House other than through these local adoptions on the part of interested but scattered groups; the overall education systems of India's states are far too entrenched and tradition-bound for reforms to be instituted more broadly. Yet this is not to say the attempt should not have been made; in the long run, *ad hoc* successes can add up to a significant whole.

More problematic--at least for a time--was the question of continuity. Dr. Fisher, for all her extraordinary energy and vision, had incorporated into the Literacy House effort one tragic flaw: an overreliance on her own charismatic leadership and personal ability to draw and provide sufficient funding to keep the effort going. When she retired from the scene in her mid-nineties, and when AID funding faded away with the deterioration of diplomatic relations between the United States and India in the early 1970s, there was no one to pick up the bulk of the Literacy House bill. The talented local staff was plunged into a mood of gloom, and several lost their jobs. Subsequently, the national and state governments picked up enough of the bill so that work could continue. But whether the lost momentum and resulting bureaucratization can still be reversed is one of those questions that crops up repeatedly in the annals of short-term histories of development efforts.

The nature of development is such that what is predictable is unpredictability. Thus one can never be sure if lessons learned in one program will prove relevant to another program in another setting. Development, in this sense, is unique and particularistic. Private and voluntary organizations that wish to be truly innovative and effective over the long run should not be overly concerned with temporary setbacks, or even with more permanent setbacks and failures. Indeed, it is often--and correctly--argued that risk-free programs cannot be expected to lead to the kind of fundamental social and economic change that is needed, particularly given the structural problems of poverty. If anything, more calculated risks need to be taken than in the past, as long as their implications are well understood in advance by both the outside agencies and the concerned local people. Voluntary organizations--because they are relatively small, flexible, and low visibility entities--are especially well suited to taking such risks for progress.

[Adapted from Chapter 5, and portions of Chapters 4 and 6 of Beyond Charity: U.S. Voluntary Aid for a Changing Third World. Published by the Overseas Development Council (ODC), Washington, D.C.; Copyright© ODC, 1977.]

# U.S. Private Voluntary Organizations In Development: An Assessment

**Elliot Schwartz**

[This article defines the comparative advantages of PVOs in development assistance, i.e., their strengths and weaknesses compared to other types of organizations. They are seen as strongest in reaching poorer people with services, in fostering innovation and self-help, in low cost of administration, and other respects.]

In general, private voluntary organizations (PVOs) can be defined as organizations that are private, nonprofit, and tax-exempt. The word voluntary refers more to the nature of the contributions individuals may make to these organizations than to their volunteer-sending programs, since few actually engage volunteers. For the purposes of this study, cooperative organizations are included within the definition while universities, colleges, and various research or scientific institutions are excluded. Of the thousands of U.S. nonprofit agencies, there are an estimated 400 to 500 that are involved in some form of assistance to less developed countries (LDCs). In addition, there are countless indigenous voluntary associations located in the developing countries themselves.

PVOs which are active overseas engage in works of relief, refugee aid, and disaster assistance, as well as community and economic development. PVOs are active in all sectors of economic life: communications, construction, education, food and agricultural development, commerce, health and population planning. The difficulty one encounters in attempting to generalize about PVOs is that they are an extremely diverse group. Yet, within this diversity, there is a community of perhaps 30 core organizations which perform the bulk of the relevant PVO activity. Increasingly, pressures

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from within the LDCs themselves, but also AID's encouragement, are pushing this community toward a more common set of operational objectives definable as development assistance--including both social services and directly productive activities. The last five years, in particular, have seen major reorientations of many PVO programs. Even the relief activities which many PVOs still engage in are being reexamined for their potential developmental impact; programs that were initiated on a relief basis often become entry vehicles for other programs which have more of a developmental impact. Thus, the PVO community has been moving toward a greater involvement in development assistance activities which run the gamut from simple nutritional education to complex integrated rural development projects.

## An Evaluation of PVO Effectiveness

The primary issue of concern to this study is to evaluate the effectiveness of the PVOs in carrying out development assistance activities. Consensus today would rate the PVOs as excellent practitioners of the basic human needs development strategy at the grass roots level. In fact, they have been the leaders and innovators of this approach, and it is here that they have a comparative advantage. There is wide respect within the development community for the work that PVOs are doing. In addition, their work is expanding in areas which development specialists deem most useful, and contracting in those thought less important (i.e., more rural development, less relief).

Seven criteria may be used in assessing the effectiveness of PVOs in meeting development assistance goals:

1. fostering self-help initiative among the poorest of the poor;
2. mobilizing U.S. private financial and human resources;
3. stimulating innovative projects which can be replicated elsewhere;
4. strengthening people-to-people contact;
5. encouraging the establishment of indigenous participatory institutions, particularly in the private sector;
6. creating the conditions for self-sustaining development efforts, which will not require outside assistance; and
7. increasing the capacity of LDC's to absorb outside capital by raising the level of local skills and resources.

Additional criteria which have been suggested are the demand for PVO services by LDCs, and relative cost-effectiveness of their services.

1. Fostering Self-help. Unlike their more well-known relief activities, the PVOs engaged in development assistance activities concentrate on encouraging private initiative. They rarely go where they are not invited, and generally undertake the role of assisting with

local self-help efforts. Many projects come about as an expression of need and a desire for help by groups which have been overlooked by government programs, although the PVO may often work directly with the host government in providing services. The Catholic Relief Services in Tanzania indicated that it is often asked to provide support--mostly monetary--to local groups who come to them as a provider of development assistance. Like most other foreign assistance donors, PVOs find that it is often easier to work with groups or individuals who are somewhat better off than the poorest. Nevertheless, because of the PVOs' largely charitable purposes and their greater emphasis on cultural awareness, they are typically more effective at working with the poorest groups than are other donors.

2. Mobilizing Resources. PVOs are capable of mobilizing substantial financial resources. It can also be said that their mobilization of human resources is substantial as well (one PVO consortium estimated that it, alone, had over 30,000 practitioners in the field). What is important, however, is that PVOs have been very successful in recruiting experienced and highly motivated technicians, educators, and administrators, despite generally modest salary levels.

3. Stimulating Innovative Projects. The PVOs have a reputation for being innovative with projects, particularly in terms of their approach toward insuring local participation and acceptance, and this is certainly true of many of them. Because of their grass roots contacts, they also appear to have a greater ability than official organizations to identify needs and assure the feasibility of meeting them. However, many PVO projects are not really any different from other projects, except perhaps for their scale or purpose--PVOs do not build hydroelectric dams. A PVO may, however, be a contractor for an AID bilateral project.

Although it is difficult to generalize, at least some PVOs are able to be more innovative in their approach because they are freer from government regulations than regular bilateral projects. For example, the "Operation Bootstrap" project for vocationalization of education in Tanzania began as an experiment to determine whether teaching basic artisan skills was feasible. Once it was proven, the government became interested in extending this activity. A somewhat different program of vocational training, initiated by Opportunities Industrialization Center International (OICI) in Ghana and Nigeria attracted the attention of other African countries, which subsequently sought to duplicate OICI projects.

The extent of replication of PVO-originated projects is difficult to evaluate, since few statistics are kept. There is, however, ample anecdotal evidence of emulation by donors designing official bilateral programs, and by national governments attempting to extend proven local work to a national level. Several examples arose in Tanzania which indicated both host government and AID willingness to copy PVO successes. There is no question that PVOs are freer to experiment than bilateral donors are, and that the ability of PVOs to demonstrate the feasibility of a particular approach often paves the way for larger scale efforts. However, it is not always clear to what extent these replication efforts are making a full or successful transition from the pilot project stage. In the Tanzanian case, for example, the PVOs were skeptical of both the national government's and AID's ability to emulate their programs, due to difficulties in attracting similarly dedicated personnel on a large scale.

4. Strengthening People-to-People Contact. Certainly the PL-480 food distribution programs, and very often other PVO programs, present an image of Americans working with and helping peoples of other countries. In some projects, however, the PVO works with a local counterpart organization, and the project might appear to be that of the counterpart. Alternatively, the PVO may cofinance with a third country PVO which might overshadow the American role. In the majority of cases, however, U.S. visibility to the project participants is apparent, and the public image is one of private Americans rather than the U.S. government (although U.S. government contributions to the PVOs are clearly identified to the host national government). It is thought that this contributes to international friendship.

5. Indigenous Institutions. Perhaps the most significant contribution to the development process by the PVOs is the encouragement of indigenous participatory institutions, mostly in the form of ongoing community structures. This is especially true at the early stages of a country's development. In particular, PVO activity has often been instrumental in assisting with the establishment of an institutional infrastructure through which individuals could be brought together and participation in development encouraged. In more advanced LDCs where this process has already taken place, the PVOs provide one of the few mechanisms for supporting private sector development since almost all other forms of aid are of a government-to-government nature.

6. Supporting Self-sustaining Development. It is difficult to evaluate the degree to which PVOs have succeeded in creating the conditions for self-sustaining development, particularly because the number of variables involved is generally too large to allow attribution of success or failure to any one source. On the positive side, it can be said that, through training techniques, the PVOs are often successful at transferring responsibility for further training or program implementation to indigenous participants. There are cases, particularly in Latin America, where PVOs have been able to phase out their participation in programs which they initiated and to have these programs continue under local auspices. On the negative side, many PVO programs do not involve income-generating activities, which diminishes the prospect of a project sustaining itself without external assistance. In a number of

cases, particularly where host government priorities and/or political pressure dictate, funding may be taken over by host government sources. However, LDC governments are besieged by funding requests, and although they may promise initially to sustain funding they are often unable or unwilling to do so when the time arrives.

7. Increasing LDC Absorptive Capacity. Because of the number of variables involved, it is very difficult to measure the ability of PVOs to increase the capacity of LDCs to absorb capital. For very poor countries, almost any increase in local skill, health and industrial levels should increase the country's absorptive capacity. The PVOs are heavily involved in activities aimed at improving education, health and production, and therefore, at least according to theory, ought to be raising absorptive capacity at the same time. The basic question, which is beyond the scope of this study, is whether the absorptive capacity is increased more by large-scale capital infrastructure projects, or through the kinds of basic human needs activities in which PVO are typically found.

8. Measuring Demand for PVO Services. This criterion was suggested by several sources, including the PVOs themselves. By this measure the PVOs must be judged highly effective at what they do. PVOs have, for a variety of reasons, become increasingly accepted vehicles for accomplishing development program goals: PVO executives generally have more project proposals pending than there are funds to finance them. The World Bank is beginning to finance and to look toward cooperation with the PVOs in order to enhance the impact of their programs at village levels. Host governments are increasingly inviting PVOs to take part directly in government programs. For example, in the southern Sudan, the Sudanese government and the World Bank are jointly financing a project under which International Voluntary Services works with village level extension workers. In Tanzania, Operation Bootstrap is being invited by the Ministry of Education to develop a nationwide curriculum in vocational education.

9. Cost of Services. A final characteristic of most PVOs is that they have been able to perform with generally low overhead costs. While there are differences among agencies, the annual averages for a representative sample of PVOs have remained only about 4 percent. To some extent this may reflect a traditional style of operation which might be improved with more expenditure on management services. But generally it seems that they can make a dollar go further than others, partly due to lower salaries and decentralized programs, and partly because their donors demand that their contributions be delivered to recipients with minimum diversion to administrative costs.

[Extracted from Private and Voluntary
Organizations in Foreign Aid, an
internal U.S. Government report,
November 1978.]

# Catholic Relief Services Nutritional Education Project in Morocco: An AID Evaluation

By Judith W. Gilmore, Carol C. Adelman,
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[The following is taken from an official project evaluation by the U.S. Agency for International Development (AID) of a nutritional feeding and education program carried out by the Catholic Relief Services, one of the major U.S. private voluntary organizations working overseas. It is included here to illustrate one of the activities in which such organizations seem to do well.]

The first food shipments from the U.S. Government under Public Law 480 arrived in Morocco in 1957. In 1972 priority was placed on feeding poor mothers and their young children. Later, it was decided that PL 480 Title II commodities should be combined with nutrition education to maximize the nutritional impact of food aid. In 1975, Catholic Relief Services (CRS) and Entraide Nationale, the Moroccan counterpart institution, designed an AID project which would integrate their ongoing food distribution efforts with a new nutrition and health education program. By 1978, when the Ministry of Social Affairs took over the program, it had been replicated on a nationwide scale.

The authors visited Morocco in February 1980 as an AID impact evaluation team. We had two major questions to answer: was the food-plus-nutrition education program dating from 1975 still functioning two years after the termination of AID funding, and if so at what level of quality? Did the program have any impact on children's nutritional status and on mothers' practices and knowledge? We collected nutritional status and behavioral data, conducted lengthy interviews with program personnel and mothers, and visited 15 of the

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program's "social education centers." We concluded that nutrition education in conjunction with food assistance has had a measurable and positive impact on the 450,000 mothers and children participating in the program.

## Nutrition and Health Setting

Morocco, with a higher per capita GNP than most developing countries, qualifies as a "middle-income" country. Yet its health and nutrition status falls short, with infant mortality up to 170 per thousand in rural areas, and severe (third degree) malnutrition in some five percent of preschool children (i.e., they weigh under 60 percent of what an average American child weighs at their ages). These data are on a par with the most malnourished countries of Latin America and exceed the median for Asian and African countries. According to a 1971 survey, some 40 percent of Moroccan children under five years old are moderately malnourished. While the poorest children weigh the same as U.S. children at birth, by three or four months detectable differences develop. The differences widen so that between 10 and 22 months of age a Moroccan child stands the gravest risk of dying from malnutrition and disease, the one compounding the other. The government and outside donors had tried to attack these conditions through the existing health system, but were able to reach, according to the most optimistic estimate, only 5 to 10 percent of the poor population. As some signs of poverty worsened, awareness quickened, and the main participants--the Moroccans themselves, the U.S. Government, and private relief groups--realized that much more needed to be done. It was in this setting that the AID/CRS nutrition education project began in 1975.

## The Project

On twenty days in each month, eleven months each year, a different group of 25 mothers arrive at the social education center--for a total of 500 mothers a month. They have their certification of "indigence" and many have malnourished children. They usually come from one to ten kilometers, and as far away as 45 kilometers in the north, on donkey or foot, often with a cluster of their neighbors. They attend the 20 to 50-minute class, register the weight of their child, pay their 2 Dirham (about $.54) fee and receive their monthly ration of food.

These activities began in April 1975 when AID approved a grant of $282,000 for Catholic Relief Services, a private and voluntary agency headquartered in New York, to introduce nutrition education courses in its 250 food distribution centers. Later, funds were increased to $453,000 and the project extended until November 30, 1978. Food commodities were provided under PL 480 Title II, equalling $8,431,020 worth in 1980, approximately 45 kilograms annually for each enrolled child under five years of age, with three rations per family. Only families certified to be below the official poverty level were eligible to receive the monthly food donations.

To launch the new education component, a nutrition institute at Marrakech was established. This institute was designed to train a cadre of competent, motivated Moroccan women at the provincial and local levels. Some 500 women from villages with social education centers were recruited and trained as teachers or "monitrices." Many of these women had previously been with the program, distributing food to mothers and weighing children at the centers, but they had worked as administrators and not as educators; they lacked training. To back them up, and to provide a means of communicating with the monitrices in their small and often isolated centers, 30 mid-level supervisors were also trained. These were women with more education, chosen through a much publicized national contest, and sent to the Tunisian National Institute for an intensive three-month training course in basic nutrition and health. Four Moroccans were selected at the same time for a three-year degree program in Tunisia; they were to assume the teaching responsibilities at Marrakech, replacing expatriates.

Right from the start, CRS and Entraide Nationale placed greatest emphasis upon making the program relevant to poor mothers' problems. They designed teaching instructions comprehensible to rural people, and used foodstuffs and materials commonly found in the villages. The curriculum they developed was a practical combination of crucial lessons in nutrition, sanitation, personal hygiene and the treatment of childhood diseases. Thus, the Marrakech Institute, the program-wide training, and the mothers' curriculum provided the foundation for the program.

## Nutritional Impact

Had the system of 300 social education centers made a difference in the nutritional status of Moroccan children? Our team analyzed an existing survey and conducted our own studies. We concluded that children in the program were less malnourished than others, and impressively so, because of the program. Even those children who were better off on entering the program maintained or improved their nutritional status. And we were convinced that the education component itself and not just the food commodities contributed vigorously to the success of the program.

The difference between program children and those just entering the program is dramatic; the program resulted in a 69 percent reduction in moderate and severe malnutrition, a difference equal to or higher than that found in most feeding programs throughout the world. The relatively large ration size in Morocco could explain some of these effects. It is greater than in most countries--45 kilograms per recipient per year--and the number of rations per family is also higher. Each mother receives three rations, one for herself, one for her child enrolled in the program, and one for a younger sibling not in the program. Thus each child is provided with approximately 40 percent of its caloric, 70 percent of its protein, and 73 percent of its iron needs; along with other foods from the family, this is more than enough to promote normal growth. But the food is usually shared among other family members, thereby reducing its impact on individual targeted children. More than half the mothers we spoke with admitted that older children or relatives consumed some of the rations. However, the size of the ration may have been enough to overcome negative effects of family sharing, making possible the powerful nutritional impact reported above.

We then examined the independent role of nutrition education in bringing about this impact. To our knowledge the impact of nutrition education on overall nutritional status has not been documented in any other study. Some nutritionists dismiss education programs; they contend that even poor mothers know what and how to feed their children and lack only the food and income, not the know-how. Other nutritionists disagree. They claim that certain feeding practices should be changed, even within the constraints of a poverty environment. This argument has proceeded without much scientific foundation on either side.

In Morocco, CRS conducted a study comparing children who received food alone with those receiving both food and nutrition education. This was possible since CRS ran a feeding program from 1972 through 1975 without an education component, which was not introduced until 1975. The study contrasted the weights of 728 program children in 1978 with those of brothers and sisters of the same age who had been in the program in 1975. The 1978 program children had experienced the complete food plus nutrition education program, while their brothers and sisters in 1975 only had food. In essence, the study looked at the 1975 "Fed" children and the 1978 "Fed and Ed" ones, and found a staggering difference. In 1975, 34 percent of the "Fed" children were moderately or severely malnourished. In 1978, only 16 percent of the "Fed and Ed" children were in this category; severe malnutrition was virtually eliminated. At the same time the program maintained the nutritional status of those who were relatively better off to begin with.

We wanted to test the Catholic Relief Services' conclusions with our own more controlled data, because the children weighed in 1978 could have received food for a longer period than the comparison group measured in 1975. We compared 1978 children benefiting from food plus education ("Fed and Ed") with comparable 1975 "Fed" children--both groups having received food for approximately the same length of time. The results argue persuasively that an impressive nutritional impact was achieved with the addition of the education program. Thirty-three percent of children who received only food were moderately or severely malnourished, compared to 11 percent of those benefiting from both food and education. Such conclusions are supported by the small study we conducted of mothers' nutrition knowledge and practices, described below.

We are convinced that the CRS program has had a major impact on the nutritional status of the children in the social education centers. But has it affected the nutritional levels of a significant number of preschool children in Morocco as a whole? Our data indicate that about 32 percent of the children entering the centers were malnourished at the outset. More than one quarter (28 percent) were moderately and 4 percent severely malnourished. The centers as a whole reach only six percent of all malnourished children under five. Clearly, the program could do a better job if nutritional status were given more emphasis as a selection criterion. Yet it is also true that too rigid a screening procedure would endanger the program's positive preventive role in keeping borderline children from sliding into serious malnutrition. The government of Morocco should try some adjusting of its selection criteria in order to improve program efficiency.

## Income Effect

The 25 mothers we interviewed in their homes all came from among the poor of Moroccan society. Only four had any formal schooling, and two others had limited training in hairdressing and embroidery. The majority of husbands were seasonal laborers or unemployed. Those with some technical skills--one was a blacksmith, one a mason and two were in farming--worked part-time or sporadically. Two soldiers (one retired) with fixed salaries were the exceptions. Our Moroccan colleagues, including a sociologist and a nutritionist, confirmed that these families were at poverty level with minimal earning capacity.

Forty percent of Moroccan families are considered poor by UN standards--below $260 per capita income. The social education center program reaches 11 percent of these families, a respectable showing for a single new program. In this context, it is clear that food aid relieves some degree of financial stress on poor families. The local retail value of U.S.-donated food is almost $11 million. This translates into approximately $73 worth of food annually for each Moroccan family participating in the program, an income supplement ranging from 4 to 24 percent of the $50 to $260 per capita incomes of these poorest families.

## Changes in Knowledge/Behavior of Mothers

In order to assess the project's impact on mothers' knowledge and behavior, we set up our own informal study. At each of the centers, we randomly selected for interviews mothers who had been in the program for more than one year. Mothers enrolled in the program for less than 3 months, or in a few cases not at all were interviewed as a comparison group. We wanted to see if real differences in nutritional knowledge and practice were evident between the 13 program and 12 comparison mothers. We looked at eight indicators, each important for good health and nutrition:

- During infant feeding, did the mothers supplement their breast milk with additional food at six months or less?
- Did they wean their babies from the breast abruptly or gradually?
- Could they describe the appropriate diet during pregnancy and nursing?
- How did they treat infant diarrhea?
- Could they name the diseases treated by vaccinations?
- Did they know the animal or vegetable substitutes to use when there was no money to buy meat?

The mothers responded as shown below. In all of the areas probed, except for animal protein substitutes (not stressed in the class curriculum), the program mothers demonstrated more knowledge of nutrition and health than the control group of mothers.

| | Number of Mothers Responding Correctly | |
|---|---|---|
| Indicator | Program Mothers<br>(n = 13) | Comparison Mothers<br>(N = 12) |
| Supplementation at 6 months or less | 13 | 8 |
| Gradual weaning | 13 | 5 |
| Pregnancy diet | 10 | 0 |
| Nursing diet | 10 | 3 |
| Diarrhea treatment | 10 | 5 |
| Diseases treated by vaccination | 2.1* | 1.2* |
| Animal protein sources | 8 | 8 |
| Vegetable protein sources | 11 | 5 |

*Mean number named per mother

Program mothers in general were aware of the importance of a balanced diet and were preparing meat or fish for their families at least once or twice a week if they could afford it. Comparison mothers, on the other hand, were less systematic about their families' food consumption, stating that they eat "what is around" or "what God provides."

In addition, all the program mothers knew how to read and discuss the program weight charts, demonstrating an understanding of the relationship between food and growth.

Catholic Relief Services' own dietary surveys, carried out in 1975 and again in 1978, had shown that participating mothers altered their weaning practices dramatically as a result of their three years of instruction. In 1975, 91 percent of the 845 mothers questioned weaned abruptly as compared to only 15 percent of the 692 mothers in 1978. The surveys also showed statistically significant increases in the consumption of protein foods, fruits and milk products by their two to five-year olds. Our conclusions, supported by CRS's own survey, indicate that there is a meaningful difference in the level of knowledge between program and comparison mothers, and that the program has been surprisingly effective in changing child feeding practices and more general attitudes towards nutrition.

When we reflected on the likelihood of such change resulting from only a dozen classes a year, it became evident to us that the social education center probably functioned as a source of health information diffusion and of informal reinforcement of nutritionally and hygenically beneficial behavior. Each center seemed to generate an elaborate network of influence which reached mothers who were not participants. In one instance where a comparison mother was well informed, we discovered that she had learned everything she knew from her sister-in-law, a long-standing program participant. We were continually confronted with evidence of this kind of diffusion. Whenever we went for an interview in a mother's home, almost always a friend or two and their children would listen in. The monitrices who conduct home visits claim that neighbors join in on most occasions. Several monitrices were asked if mothers who were not in the program ever sat in on the educational sessions; answers ranged from 15 mothers a week up to seven a day. Every center where we inquired has a waiting list of 10 to 150 mothers. At Zagora, 1000 women from a single mountain village requested the opening of a new center nearer their home. In Ouarzazate province, teaching materials gathered from the center were being considered as a model for a new primary school booklet on nutrition and health.

## Evolution in Women's Roles

In some communities in the early 1970s when the feeding program was just beginning, women did not venture out of their homes, even to pick up food from the local centers. Men persisted in bringing their children despite the urging of monitrices to let the mothers come. According to Mohamed Barbach, Director of the Agricultural Center in Beni Boufrah, "The husbands would not let their wives go out. They had the key." By 1974, this pattern was already changing.

We became convinced that part of the power of the centers had to do with the evolving status and role of women in Moroccan society. The impact of the center on the role of women might even be greater than the impact on the practices we have discussed, but more difficult to document. Several women simply told us that before the center they went out of their home only for food, water, and fuel--and to visit with an occasional neighbor. This also seemed to be a truism among the community leaders we interviewed. The centers appeared to be--and were certainly perceived to be--a key factor in providing an opportunity for women to share in the benefits of a broader community life.

The monitrices encourage access to a wide range of social services, such as vaccinations, hospitals, child care facilities, schools and women's associations. The social education center itself is usually part of a larger Ministry of Social Affairs complex, sometimes shared with an activity of the Ministry of Youth and Sports or the Ministry of Agriculture. It is often located near a Ministry of Health dispensary. Mothers feel more comfortable with these medical services after having been to the center, and have reported receiving more prompt treatment because of the center's intervention. More women are now giving birth in hospitals, particularly when a first child is involved or prenatal difficulties are foreseen. Some credit the centers with influencing women to have their children enrolled in child care centers or primary schools. Others noted that mothers from the centers were more receptive to changing their health practices:

> There is a difference between mothers from the center and others (who come to my dispensary). They are more educated; they follow the treatment better; they come to the dispensary sooner than the others. For vaccinations, I have to go out and chase in the others, but the mothers from the center come in on their own.
>
> -Alharrak Najib, M.D., Beni Boufrah

At some centers, up to 35 mothers a week return on a non-class day to discuss their problems with the monitrice. Many of these women are asking for counseling services or more education to fulfill their personal aspirations.

The monitrices and provincial directrices have found the CRS program to be a means of upward mobility. These women from lower class families and limited educational backgrounds would normally stay at home or at most enter low paying or volunteer social work. Most provincial directrices interviewed were recruited directly out of secondary school; about half the monitrices we met had been involved in social service activities while the others stayed at home or had housework-related jobs. After joining the program these women acquired a new stature in their community. They had steady jobs with fixed salaries.

## Institutional Strength and Growth

Despite the ending of AID funds in December 1978, we found a solid, well-organized system which had expanded since the program's transfer to the Ministry of Social Affairs in early 1979. Since then, 50 new centers have been created, 100 new monitrices trained, and a new curriculum developed for a fourth year of training. In addition to the port, warehousing and inland transportation costs of food shipments--which they have always paid--the Government of Morocco has taken over all project administrative expenses since 1979. This includes the costs of continued CRS assistance, the training school at Marrakech, all administrative personnel, and the salaries and travel of the provincial directrices. The Government contributes some $4.7 million annually for the successful operation of this program. In addition, the local center costs including the monitrices' wages are financed by the mothers themselves. The mothers' monthly payment was recently doubled to 2 Dirhams ($.54) in order to improve the salaries of the monitrices.

From on-the-spot observations in 15 centers (11 randomly selected), we noted consistently good operational procedures:

- Delays in food deliveries were the exception not the rule;
- Each center maintained excellent and uniformly kept records;
- Monitrices interacted actively with mothers, creating an excellent teaching and learning atmosphere;
- Infant weighing procedures were being followed and an improved system of referrals to health care facilities had been introduced;
- Monitrices conducted weekly home visits to follow absent or sick mothers;
- Provincial Directrices were visiting each center on a monthly basis as scheduled.

During our tour of the field sites, we observed several classes and were impressed with the dynamism of the monitrices. They followed the lesson plan printed on their plastic class outline guides and seemed to be well trained in the use of demonstration materials and posters. But what transpired was not a rote repetition of an exercise learned at Marrakech; an extraordinary level of interaction between the monitrice and mothers took place with comments, questions, answers, or stories contributed by mothers. For classes at four different centers, we tabulated an average of 3.4 responses per minute, with 79 percent of the mothers making individual comments. This high level of interaction indicated an opportunity for learning far superior to the more static lecture or rote response styles witnessed by team members in other countries, and in other settings in Morocco.

Cost-effectiveness. The Morocco feeding program cost of $34.47 per person per year is roughly comparable to other feeding/education programs throughout the world, given its contents. Costs of similar programs range from $10 in Kenya to $32 in Colombia. These are below the Moroccan figure mainly because the calculations were made over four years ago when food prices were lower. Also, few if any of these programs had full-scale nutrition education components or features like the Marrakech training school. Considering the nutritional and other impacts of this program, it is extremely cost-effective in comparison with the majority of feeding programs, which have shown little or no nutritional impact.

Dependence on food. The program's reliance on food aid is an inherent problem if one starts to consider its future. This dependence inhibits its present potential for expansion, and could endanger its continuation if there should be any uncertainty in PL 480 food deliveries. It is questionable whether Morocco can import enough food for its own private consumption needs, let alone government food donation programs. Substituting local foods for PL 480 Title II commodities would require a major reorientation of agricultural and economic policies designed to boost domestic production. It is important to begin to consider whether and how donated food can be phased out without diminishing the program's nutritional impact.

## Conclusion

The Moroccan example highlights what is possible to achieve--in a reasonably cost-effective manner--when nutrition education is combined with food distribution. It is difficult to say with precision whether food or nutrition education was the determining element. This report contains data which suggest that nutrition education contributes significantly to nutritional improvement. On the other hand, in order for nutrition education to work, it appears that a minimum amount of food may be necessary to counteract the effects of family sharing and, at the same time, provide a fairly substantial income supplement to poor families. What seems clear is that few of these nutritional impacts would have occurred to the degree observed with a feeding program alone.

[Extracted from Morocco: Food and Nutrition Education, and AID Project Impact Evaluation report on Grant No. AID/NESA-G-469, August, 1980.]

# Voluntary Agencies and the United Nations

Tristram F. Betts

[Private voluntary organizations have a tradition of independence, but in the Third World development field there have been a number of moves toward coordination and even joint organization. The U.N. has had a role in bringing these organizations into the field and in some joint programs.]

According to the Development Assistance Committee of the Organization for Cooperation and Economic Development (OECD), the grants made by the voluntary agencies of its member countries in 1974 totalled $1,217 million and $1,371 million in 1975. These totals give a measure of the formidable contributions made from voluntary sources. We cannot assume that the greater part of the activity they represent lay in the field of development as such, nor that any specific proportion of this funding was directed as a matter of principle to the twenty-nine Least Developed Countries within the UN definition. However, an examination of the current program of the major European agencies reveals an important involvement in most of the countries in the UN list of the least developed; for example, for Oxfam--21 countries; for the Organization for Rehabilitation through Training (ORT)--12 countries; and for the recently formed Euro Action-ACORD group--5 out of the 7 countries with which it is so far involved. But these are pragmatic actions incidental to a policy of concern and response wherever human need is brought to their attention. In general then, the attitude and policy of most, if not all, of the voluntary agencies lies closer to the World Bank concept of Poverty Target Areas than to the current UN emphasis on the Least Developed Countries.

Mr. Betts, after a career as a Conservator of Forests in Nigeria, worked as rural development adviser for OXFAM, IUEF and the International Council for Voluntary Agencies and as a consultant in this field for several United Nations Agencies.

It is possible today to detect within a number of the major agencies, and even in their representative body, the International Council of Voluntary Agencies (ICVA), certain hesitations, and even skepticism over some aspects of UN development activities, despite the fact that a fair amount of collaborative effort does exist. This situation makes it the more important to recognize that it was two particular types of UN-inspired activity in the 1960s which sparked off the emergence among the main body of voluntary agencies of a developmental, as opposed to a purely welfare, philosophy.

The Freedom from Hunger Campaign. The initiation by the Food and Agricultural Organization of the United Nations (FAO) at the beginning of the 1960s of the Freedom from Hunger Campaign (FFHC) has proved to be one of its most enlightened achievements. The formation of National Freedom from Hunger Committees in the donor countries, and the resulting enhanced availability of information about Third World problems, immediately caught the imagination of the major agencies. To give only one example, it was the FFHC which induced Oxfam to adopt its system of field directorates and redirect an increasing proportion of its funds from short to long term projects. The voluntary agencies, moreover, soon found that the publicity campaigns mounted by the FFHC, allied with their own publicity procedures, paid off in a widening and deepening of their fund-raising capacity. This in turn led to an increasing emphasis given by the private agencies to public education in the donor countries on Third World questions, a process aimed not merely at existing and potential adult contributors but also at the adolescents in schools and universities who could become their future constituents.

In addition, the FFHC created the opportunity for collaboration in the field between FAO and a number of the voluntary agencies involving joint activity at the grass roots level. These projects were modest in concept and frequently failed; but a considerable number survived which have had, and still have, great value as pilot schemes from which the participants and the voluntary agencies acquired valuable experience. One of the problems we face today is how the intimate relationship with the local people and the high motivation of the volunteers engendered in such projects can be preserved when attempts are made to extend them on a wider regional or national scale.

The Refugee Problem. The other area of joint activity between voluntary agencies and the UN system since the mid-1960s provides an obverse image of the one just related. The Office of the United Nations High Commissioner for Refugees (UNHCR), by the statutory limitations imposed upon its functions, was not itself an operational body and cannot be defined as a development agency. In its early years its prime pre-occupation was a definition of the legal status of refugees and the establishment of refugee rights and privileges in the countries of asylum. Its first involvement was with the displaced persons of Europe and elsewhere resulting from the Second World War, a process far removed from the problems of the Third World. It was not until the middle 1960s that the displacement of rural people arising from colonialist struggles and the problems of post-colonial adjustment in Africa confronted the UNHCR with the problems of major rural settlement.

The initial need was for immediate medical succor, food and short-term shelter for thousands of families streaming destitute across unfrequented borders, sometimes under hot pursuit or in general panic. UNHCR chose as its operating agent the International Red Cross, itself backed by contributions from many voluntary agencies. At first, there were hesitations over providing permanent settlement for these people because of the possibility of an early return to their countries of origin. Later, however, when these hopes were dashed (as in Burundi, Uganda and Tanzania) the necessity for permanent settlement became mandatory, first, to remove the refugees to secure areas, and second, to save them from pauperization and re-establish them on a more permanent basis in areas allocated through generosity of the governments of asylum. Inevitably the land which could be spared for this purpose lay in areas of sparse population, only partially inhabited by the nationals of the country because of hostile natural environment with minimal infrastructure and communications.

Thus UNHCR was drawn into a wide spectrum of activities of which it had little experience including: the establishment of road networks, of village water supplies, and simple medical and educational services; the clearing of land and the drainage of swamps; eradication of the tsetse fly and other pests; and the establishment of agricultural crops. The governments of asylum themselves, over-strained by their own developmental efforts, could make little contribution in these remoter areas. With only limited backing from any of the UN Specialized Agencies, UNHCR had to rely primarily upon voluntary agencies. Thus in Tanzania there evolved a tripartite arrangement whereby the Lutheran World Federation (LWF) became the executing agency in the field in partnership with the Tanzanian government and UNHCR itself. In Burundi the Association Internationale de Developpement Rural (AIDR) played a similar role. Behind these was the strong support of a number of other voluntary agencies, notably the World Council of Churches (WCC), Oxfam and the Scandinavian refugee organizations, which provided technical and planning assistance as well as funding.

The 1967 Conference on African Refugee Problems initiated a widening debate on the problems of rural development and the part which the voluntary agencies should play in it. In that year, Oxfam in particular introduced a new professionalism in its approach to refugee settlement by inviting (on a fee-paid basis) the professional services of the recently-formed Agricultural Development Service of the World Bank for the planning of an integrated approach to certain problem areas in Tanzania and Uganda. In 1968, the Oxfam field representative was invited by the United Nations Development Program (UNDP) to participate as a consultant in a Preliminary Assistance to Government Mission on rural development to Uganda.

## The ICVA Working Group on Rural Development

The International Council of Voluntary Agencies (ICVA) was formed in 1962 to act as the clearing house and contact point for over 100 major agencies. During its 1968 General Conference in London, major attention was devoted to the subject of integrated rural development and the possibilities of joint action by voluntary agencies. Arising from this, the Scandinavian countries mounted a series of seminars to which the Oxfam field representative, now accepted as a specialist in this field, was invited to lead discussion on the same subject. These discussions in London and Scandinavia resulted in 1969 in the formation within the ICVA of a standing Working Group on Rural Development. Under the aegis of one of the member organizations, the International University Exchange Fund (IUEF), a field office in Nairobi was established to assess the possibilities of voluntary agency intervention in Africa.

There remains, however, a strong body of resistance within the ICVA membership against the surrender of individual agency autonomy to the joint action concept. One of the weaknesses--as well as strengths--of the voluntary agencies is their individualistic specialization and their jealously guarded independence. The advantage of this individualism has been that their fund-raising efforts have shown little overlap, and each organization has developed its own constituency. A disadvantage is that attempts to achieve united action and the pooling of resources in face of a commonly recognized need remain extremely difficult. It is fair to say that, even before the ICVA General Conference of 1968, a number of the major agencies had begun to think and act in terms of development activity as such and even, in some cases, to create special sub-sections of their organizations for work in the development field. For example, the Lutheran World Federation established a Community Development Service which, between 1962 and 1976, endorsed some 662 development projects, mainly in the medical, agricultural and educational fields, at a total cost of some $52 million. At a later stage, and covering similar fields of activity, the Catholic churches of North America and Europe created the organization International Cooperation for Socio-Economic Development (CIDSE) with headquarters in Brussels, concentrating mainly in the field of human development at the village or institutional level--allocating in 1973 alone some $51 million to these purposes. On a similar scale a nondenominational agency, Concern, was formed in 1968 in Ireland with a prime interest in education, rural development, health and agriculture in the Third World. In 1976, Oxfam in the United Kingdom, was devoting some 67% of its $8½ million income in that year to health, social development and agricultural projects. These examples could be multiplied. But this new consciousness of development needs did not necessarily imply a greater willingness to avoid duplication of effort and to achieve a more efficient economic pooling of resources by accepting common action.

## The Evolution of ACORD

From the ICVA Working Group meeting of 1972 there emerged one group of agencies, a rump perhaps of the total but a very powerful one, which persisted with the concept of joint action. It comprised the African Medical and Research Foundation International, Nairobi; Church World Service, New York; the Danish Refugee Council, Copenhagen; the International Organization for Rural Development, Brussels; the International University Exchange Fund, Geneva; the Norwegian Refugee Council, Oslo; and Oxfam, Oxford. These agreed to come together in an informal consortium for the funding and prosecution of a particular major project in Sudan, at a cost approaching $1 million, for the establishment of a multi-purpose training center for Southern Sudanese artisans and secretarial staff in Juba. This project and this form of joint action received the warm support of the Sudan government, and despite logistic difficulties has had a resounding success.

The formation of this consortium was probably the most significant outcome of the May 1972 meeting. It later acquired legal status under Swiss law as the International Agency for Cooperation and Development (IACOD). Since the Sudan experience it has gone from strength to strength, attracting to its membership additional organizations such as the Canadian University Service Overseas and the Overseas Development Group of the University of East Anglia in the United Kingdom. In 1974 the decision was taken to redefine more closely its objectives and to change its name accordingly. Under this new title, the Agency for Co-operation and Research in Development (ACORD), it was an organization concerned not merely with fundraising and the propagation of information about Third World problems, but was itself primarily a field agency. It began by expanding its program in the Sudan beyond vocational and rural development training into such activities as rural water supplies, scholarships and educational support. Later it was drawn into the critical situation in the Sahel where it was commissioned by another group of eight European non-governmental organizations, known as the Euro Action Sahel group, to administer a large long-term development program in Mali, Upper Volta and Niger. This program includes projects involving the re-organization of cooperatives and development schemes to benefit nomads and small farmers. ACORD has extended its interest to specific development possibilities in the new Portuguese speaking nations and in Tanzania. A natural and significant outcome of these activities has been an agreement between the Euro Action group and ACORD to join forces as a single organization known as Euro Action-ACORD, with headquarters in London, in 1977.

In some cases, Euro Action-ACORD may be asked to mount an operation by itself; in other cases, one or other of its member organizations may be asked to undertake the operational function with the joint backing of the body's membership. This obviously offers some answer to the criticisms voiced regarding the embarrassment caused to recipient governments besieged by a multiplicity of voluntary agencies. The greater the concentration of inter-agency effort, the easier becomes the relationship with the government concerned. Yet this particular difficulty may have been somewhat overstressed, for it is true that generally speaking the relationships between voluntary agencies and recipient governments have been smooth. In more than one recipient country, for example, voluntary agency participation has been approved in such bodies as the local Freedom from Hunger Committees; in others, such as the LWF Community Development Service in Tanzania and the Christian Council of Kenya, they have been incorporated directly within government programs. The lack of information available to recipient governments regarding the capabilities and objectives of the voluntary agencies which approach them remains a problem, however, and it is important that a more coherent catalogue of such information should be made available.

A further advantage of the more comprehensive resources of Euro Action-ACORD is the capability it has acquired for involvement in much longer term commitments than were previously undertaken by voluntary agencies. Until recently it has been a weakness of voluntary agency activity in the development field that most of them have been unable or unwilling to commit themselves to projects of more than one or two years duration, mainly because of uncertainty about their own continuing fund-raising capabilities. For similar reasons, the projects they have adopted have lacked the vital follow-up and the coherence of approach necessary to give their invaluable grass-roots experience the opportunity to grow and widen over significant areas. The plea has been made in the past by such organizations that it has been their function to recognize a spark in a locality, to fan that spark to significant dimensions by means of projects which would be pilot operations ("poles de développement") and to show the way for more competent authorities to follow. But, without an assurance that this follow-up will take place, such spark-off projects can die a natural death; and to light a fire and achieve an involvement--an enthusiastic involvement--within a rural community, and then leave, can lead too often to disillusionment among the people who made the original effort. Fortunately, the growing confidence of major voluntary agencies in their accelerating fund-raising capability and the increasing recognition and support they are receiving from their home governments has made them less wary about the commitment of funds. Consequently, in a context where fifteen years is a significant period to achieve results, they are moving from commitments of one or two years into five years or more.

## Bilateral Government Funding through Private Organizations

The question of the acceptance of financial assistance from their home governments has caused a good deal of debate and hesitation among voluntary agencies in the past. One difficulty has been over the fact that in the past bilateral official aid was often tied, confining the use of such funds to the products of the donor country, a practice which itself is alien to the voluntary principle. Furthermore, there has been a feeling that to accept any major measure of governmental aid ran the risk of a confusion in the minds of voluntary agency supporters between freely made charitable contribution and government taxation, to the detriment of the former.

Despite these hesitations, however, the relationships between the voluntary agency movement in various countries and their governments have shown steady growth and improvement in attitudes. In the United States, for example, two main denominational voluntary agencies, Catholic Relief Services and the Church World Service, have long been recognized as important channels of government food and material surpluses for both emergency and developmental purposes. Scandinavian governments have been content for a number of years to provide a regular budget to specified voluntary agencies without strings attached. In West Germany the major religious voluntary agencies have received significant financial support from a government-levied church tax. In 1971 the International Development Agency of the Canadian Government (CIDA) adopted a most enlightened collaborative policy with the voluntary agencies of that country; and in 1974 the British government through its Ministry of Overseas Development adopted a similar policy on a more modest scale. The emphasis placed by CIDA on the elimination of bureaucratic procedures in its relations with agencies and recipient governments is hopefully and indication of a similar trend in attitude among other donor governments.

## UN-Agency Collaboration

Despite the more secure and coherent mobilization of resources by the private agencies and their growing sureness of touch towards, and involvement in, rural development, there persists a mood of skepticism towards the methodology employed within the UN system, a skepticism which is the main stumbling block to the achievement of common or at least complementary programs. It is the writer's contention that the root cause of this unease lies in the fact that within the UN system it has become almost axiomatic that where development projects are sited in the rural areas FAO is chosen for its technical competence as the operating agency, without reference to the deeply felt immediate social needs of the people directly involved. There is indeed a wide debate within the agencies involved in rural development between two schools of thought. The first of these, epitomised by FAO, argues for what has been described as the "bang bang" or "initial thrust" attack on economic backwardness in rural regions, by selecting areas which offer the highest promise of immediate economic return and in which an intensive concentration of capital inputs and expertise can (hopefully) achieve an observable and significant increase in the GNP. The contrary argument, which commands the support of the major voluntary agencies, is that to concentrate economic development in the more favored areas of the country is to neglect and intensify the poverty and backwardness of the less fortunate areas.

Despite this cleavage of opinion, there does appear to have recently emerged, at least in principle, in the higher echelons of the UN system and among bilateral and non-governmental organizations one general area of common ground. A great deal of lip service is now paid to the importance of involving the people themselves at the grassroots level in rural development, whatever form it may take. Space does not permit reference to the case histories that support the following observations from a special investigation of rural development programs in Africa in 1975-76, commissioned by UNDP, which form a precis of the writer's findings. These are: A.) That however explicit the views expressed at headquarters regarding popular involvement and participation in project planning and execution, there is little evidence that in FAO-managed projects it has penetrated effectively to field level; B.) That the projects most successful in achieving popular participation have been the small scale schemes, usually FFHC and usually with private agency involvement, with modest targets and modest resources, and with minimal expatriate expertise and a significant volunteer element; but that the problems of translating such comparatively modest programs into large scale area activity have so far proved difficult to resolve; C.) That generally speaking (often self-admittedly in hindsight) the major constraint common to most projects has been the failure of project management to win over the active participation of the people; and this is a phenomenon which bodes ill for the perpetuation of project aims and objectives once outside assistance is withdrawn.

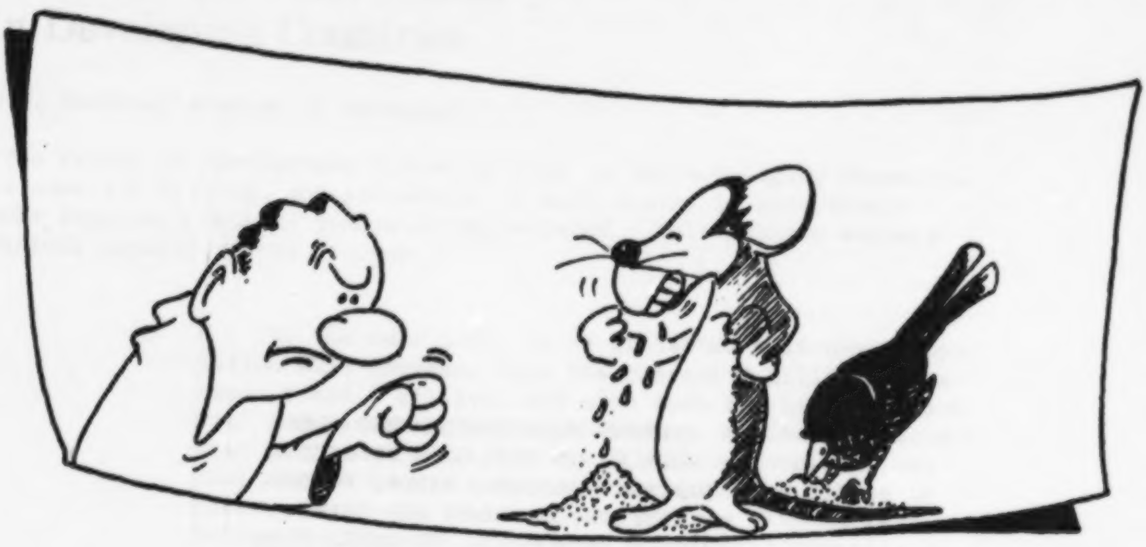
Surely the opportunity exists for a much more effective interplay between UNDP and agencies such as Euro Action-ACORD. It is suggested that it would be a wise move to incorporate in the UNDP Resident Representative's Offices in the recipient countries an individual seconded from the voluntary agencies, to keep him informed of the possibilities for voluntary agency participation in development projects, particularly during their preliminary phase. UNDP might employ a sub-contracting system: for example, by bringing in the African Medical and Research Foundation as a sub-contractor to WHO in the health field; and perhaps Euro Action-ACORD in the fields of rural training and village amenities. Such a proposal will undoubtedly arouse strong opposition, especially from those in the voluntary agencies who would mistakenly consider the acceptance of a sub-contracting role, even on a freely negotiated basis, as beneath their dignity and a threat to their identity. It is nonetheless an area of discussion which deserves to be pursued.

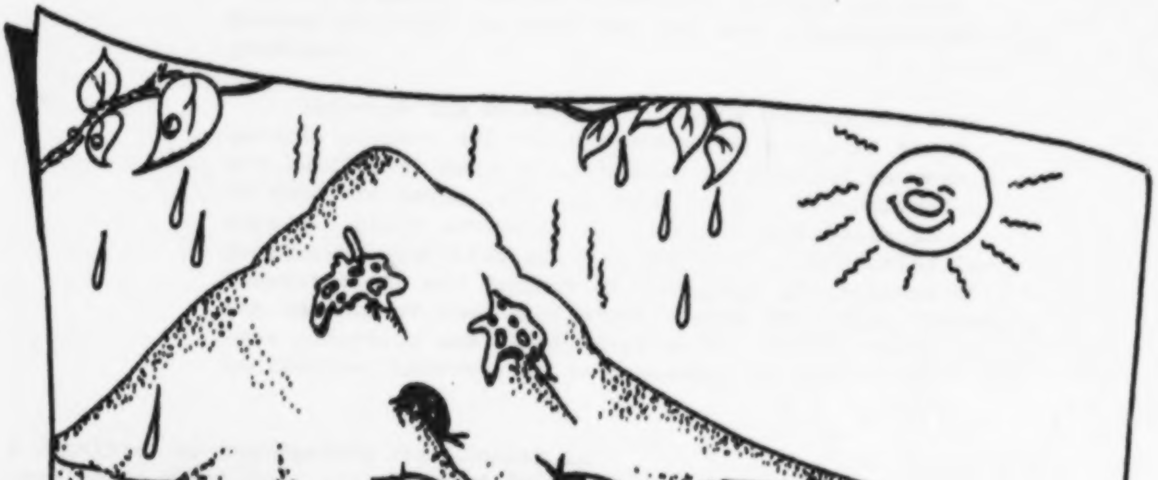
## Conclusion

In this paper so far we have traced the development and increasing maturity of the voluntary agency approach, but we have not explored the motivations behind it, an issue which is of curcial importance to the recipient governments. How is it that during a period of world slump and economic difficulty in the Western world, the incomes of their voluntary agencies, drawn mainly from the contributions of millions of ordinary men and women, have not only sustained themselves but have been accelerated? The explanation can only lie in the persistent basic Samaritan spirit which exists in ordinary people in spite of circumstance. Many of us will remember the surge of hope which flooded the Western world with the creation first of the League of Nations, and then of its successor the United Nations. While the UN Development Programme today suffers from increasing financial stringency, the voluntary agency movement appears to go from strength to strength. From the point of view of the Western World it has its basis in the Christian ethic. Elsewhere the sensitive teachings of the Koran in regard to charity are the motivating force. Yet this magnificient response from ordinary men and women of goodwill goes beyond denominational preaching. It is clear that the reaction among ordinary people when confronted with the sum of misery in the poorer areas of the world is a deep unease at their own more privileged situation.

[Extracted from "Development Aid from Voluntary Agencies to the Least Developed Countries," Africa Today, Vol. 25 No. 4, Oct.-Dec. 1978, pp. 49-62. Copyright© 1979, Africa Today Associates, Denver, Colorado.]

# POST-HARVEST FOOD LOSSES





CARTOON ILLUSTRATING THE MAIN SOURCES OF FOOD LOSS FOLLOWING HARVEST--RODENTS, BIRDS, FUNGUS, INSECTS, DAMPNESS AND HEAT. (CARTOON FROM MANUAL ON SMALL FARM GRAIN STORAGE--SEE ARTICLE P. 110.)

# Post-Harvest Food Losses In Developing Countries

U.S. National Academy of Sciences

[The extent of postharvest losses of food in the developing countries is some $10 billion, and prevention of such losses is accordingly more important than is generally appreciated. This article surveys various aspects of the problem.]

By the year 2000, it is projected that world population will increase from the present 4 billion to between 6 and 7 billion, and with them the need for food will grow at least proportionately. Estimates indicate that between 450 million and 1 billion people do not have enough to eat now, and this number is likely to increase with the population. To cope with current and future food demand, governments have traditionally emphasized two lines of action: reducing future demand by slowing population growth, and augmenting food supplies by expanding production. A third vital complementary measure, however--reducing the loss of food during and after harvest--has not been adequately emphasized.

Although the methods of loss estimation are frequently suspect and the supporting data rough, there are sufficient data to show that substantial amounts of food are being lost annually in the post-harvest system. Since estimates of loss and production in developing countries are subject both to differing interpretations and degrees of accuracy, projections of the amounts of food that might become available through loss reduction are doubly difficult. Within these limitation, however, it is necessary to make rough

A Committee on Postharvest Food Losses in Developing Countries, with Prof. E. R. Pariser of the Massachusetts Institute of Technology as Chairman, was organized to make this study for the National Academy of Sciences, Washington, D.C.

approximations to illustrate the possible magnitude of the losses involved as a guide to policy.

Conservative expert opinion resists generalizations of loss estimates because they cannot be substantiated by statistically sound data. For planning purposes, experts cite minimum overall losses of 10 percent for durable crops like grains and 20 percent for nongrain staples, perishables, and fish. Table 1 gives an extrapolation in monetary terms of these minimum loss estimates for 1976. The figures in Table 1 indicate that in the developing countries a conservatively estimated minimum of 42 million metric tonnes of cereal grains and legumes were lost in 1976; this amount is equivalent to 60 percent of the annual total cereal production of Africa, 95 percent of Canada's annual cereal grain output, and slightly more than the production of Indonesia and Thailand combined. At 250 kg per year, this tonnage would provide more than the annual minimum calorie requirements of 168 million people--twice the population of Pakistan, or a quarter of the population of India.

TABLE 1 1976 Estimates of Minimum Postharvest Food Losses in Developing Countries*

| | Durables | Perishables | Fish |
|---|---|---|---|
| 1976 food production (million tonnes) | 420** | 255** | |
| Estimated minimum loss percentage | 10 | 20 | |
| Estimated minimum loss (million tonnes) | 42 | 51 | 10*** |
| Estimated price/tonne (US $) | 165**** | 25 | 225*** |
| Estimated loss value (US $ billions) | 6.9 | 1.3 | 2.3 |

*"Developing Market Economies" according to FAO (1977) definition.

**Production estimates from FAO (1977) assuming 79 percent of durables and 75 percent of perishables are actually used for food (based on NRC, 1977).

***James (1977).

****Figure used by the International Food Policy Research Institute (IFPRI, 1977).

Table 2 presents analogous calculations based on projections of food crop production in 1985 and continued losses and prices at present levels. These figures represent a conservative minimum estimate of 107 million tonnes of total posharvest food losses, which, together with 10 million tonnes of fish losses, is valued at approximately US $11.5 billion. Successful implementation of the United Nations General

Assembly VIIth Special Session Resolution calling for a 50 percent reduction in postharvest food losses by 1985 would, therefore, save an estimated US $5.75 billion worth of food annually.

TABLE 2 1985 Projections of Minimum Postharvest Food Losses in Developing Countries

| | Durables | Perishables | Fish |
|---|---|---|---|
| Projected 1985 food production* (million tonnes) | 472 | 302 | |
| Estimated minimum overall loss percentage | 10 | 20 | |
| Projected minimum losses (million tonnes) | 47 | 60 | 10 |
| Estimated price/tonne (1976 US $) | 165 | 25 | 225 |
| Estimated loss value (US $ billions) | 7.8 | 1.5 | 2.3 |

*Based on approximately 2 percent annual increase from 1976 FAO production reports and figures in the World Food and Nutrition Study (NAS, 1977, Appendix A, Table 1) of approximately 75 percent of total durable crop production used for food in 1985. Also assumes the proportion of durables to perishables produced in 1976 (61:39) will hold for 1985, and that there are no improvements in food conservation.

A 2 percent annual increase in production of food crops over 1976 volume would result in a production of durables very close to the projected demand figures for grain in 1985--474.5 million tonnes. However, even if this production were achieved, a shortfall of food grain would result because of the projected postharvest loss--a minimum of approximately 47 million tonnes. Production sufficient to meet both the projected demand and the estimated 10 percent postharvest loss would require an increase of 2.85 percent annually. But if the United Nations Resolution's 50 percent loss-reduction target were to be achieved over this period, the annual production increase required could be reduced to 2.32 percent.

## General Causes of Postharvest Grain Loss

Knowledge about the nature and extent of postharvest losses is much more extensive for cereal grains and grain legumes than for other commodities for a number of reasons. In most societies, these more durable foodstuffs are (or have been) the most important in terms of quantity produced. They are traditionally stored, and the survival of a society has depended on keen attention to this process (this has been less true in the case of the nongrain staples.) It is easier to protect dormant dried grain from external attack by insects or rodents than it is to prevent physiological deterioration or fungal attack of perishables. Perishables are often seasonal crops that provide a relatively constant supply of a variety of fruits and vegetables without storage. Many grow with minimum attention; their husbandry is therefore much less important and demanding than that of durable staples.

The bulk of harvested cereal grains and legumes passes through a fairly well-defined series of steps--the postharvest system. After harvest, the crops are threshed or shelled, dried, stored, and finally processed. Each commodity has its own variations in this process and some have additional steps that enlarge the system (rice parboiling, for example), but there are enough similarities in the flow of durables through the system to enable generalization about loss problems.

Preharvest factors. The genetic characteristics of a grain variety greatly influence the postharvest losses it is likely to incur. Traditional varieties are generally well adapted both to their usual environment and to post-harvest handling. The grains that survive storage and are used in subsequent seasons have evolved characteristics that favor their survival. These may include, for instance, lower moisture content in the ripe grain, which then dries more readily, and a thicker seed coat for repelling insects and rodents. The introduction of varieties selected for high yields has resulted in greater postharvest losses where the new varieties are not as well adapted to postharvest conditions as traditional varieties. This problem should be a consideration both in selecting high-yielding varieties and in providing for their postharvest treatment.

Damage to the growing crop may affect its postharvest characteristics, as may crop protection treatment prior to harvest. In particular, insect infestations of a maturing crop may increase its vulnerability to loss after harvest; however, residual insecticide may reduce the extent of postharvest insect damage.

Harvesting factors. The time at which harvesting occurs has an important effect on the subsequent storage quality of the grain. Typically, the harvest may begin before the grains are fully ripe and may extend until mold and insect damage are prevalent and shattering has occurred. Grain not fully ripened contains a higher proportion of moisture, and will deteriorate more quickly than mature grain because the enzyme systems are still active. If the grain remains in the field after maturity, repeated wetting from rain and dew at night, along with drying by the hot sun, may cause grain to crack (particularly long-grain paddy), and may increase the likelihood of insect damage (especially in maize, paddy, and pulses).

Crops standing in the field after maturity become more liable to harvest losses. Ripened grain is more likely to be shattered onto the ground during harvesting. Maize loss may result from the loosening of the ripened husk and subsequent mold infection or insect attack. The probability of insect infestation in the field is also likely to increase if the crop stands too long, as is loss to rodents, grain-eating birds, and other vertebrates.

Threshing and shelling. Traditional methods of threshing to separate grains from the plant, such as the use of animals to trample the sheaves on the threshing floor--or its modern equivalent, using tractor wheels--may result in the loss of grain not separated. This method also allows impurities to become mixed with the grain, which may cause subsequent storage problems. The use of flails to beat the grain from the stalk may also damage the grains or kernels and is not always effective. However, modern threshing and shelling devices may also be used incorrectly, or on crops for which they were not intended, often resulting in excessive grain damage. Generally, threshing and shelling will contribute to losses if carried out in a manner that cracks grain.

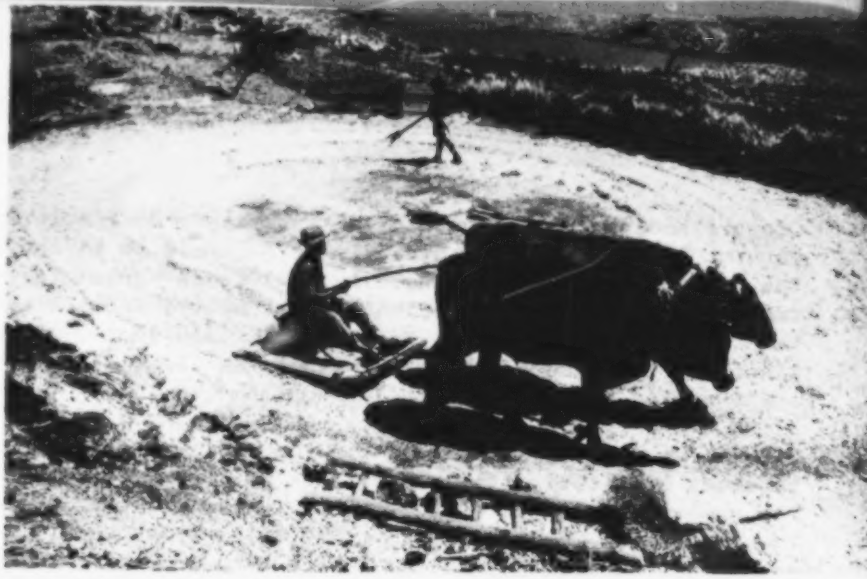
Drying. Drying is a particularly vital operation in the food handling chain, since moisture may be the most important factor contributing to the rate of deterioration during storage. Drying is used to inhibit germination of seeds and to reduce the moisture content to a level that prevents the growth of fungi and bacteria; it can also retard attacks on the grain by insects and mites.

In developing countries, the methods available to farmers for drying crops are often limited to a combination of sun and air drying, although supplemental heat is frequently employed. In many cases, seed grain may be treated separately from food grain and with greater care. Drying is a complex process requiring considerable skill and effort on the part of the farmer. The success with which the grain is preserved over shorter or longer periods depends to a great extent on the care and attention given to the drying and subsequent storage. Drying is often complicated by the introduction of high-yield varieties or by production of a second, irrigated crop (double-cropping) that matures and must be harvested during wet seasons. In these cases the grain requires artificial drying. The increased production of high-yield varieties and their differing characteristics may also tax the farmer's ability to handle the grain properly by traditional methods. Consequently, new drying and storage procedures must be adopted or the crop must be sold undried.

Overdrying--which can easily occur in arid regions, or after excessive exposure to sun or other heat--can cause breakage, damage to the seed coat, bleaching, scorching, discoloration, loss of germ-

Right: Traditional threshing with ox-drawn "norag," Lebanon.

Below: Rice threshing, Indonesia.



Below: Field drying paddy, Indonesia

Below: Sun drying millet, South India.

inative power and nutritional content. Too-rapid drying of high moisture crops also causes damage; for example, bursting (or "case-hardening"), which causes the surface of the grain to dry out rapidly, sealing moisture within the inner layers. Underdrying or slow drying (a problem in humid regions) results in deterioration due to fungi and bacteria, and, in extreme cases, leads to total loss.

Solar technology for artificial drying is receiving attention because of its negligible running costs in comparison with traditional fuels, which are becoming not only expensive but, as in the case of firewood, harder to find--consumption of wood is causing deforestation in many areas. However, the fundamental problem with solar devices is that they do not operate effectively when they are most needed--to dry grain that must be harvested during a wet spell or in the rainy season.

The manual used by the Peace Corps and Volunteers in Technical Assistance (VITA), *Small Farm Grain Storage* (Lindblad and Druben, 1976), contains descriptions and instructions for constructing a variety of improved grain dryers, including a pit oil barrel dryer, an improved maize drying and storage crib, a simple batch-type rice dryer, and a number of simple solar dryers. Clearly, methods of drying must be selected for the particular climatic, economic, and social circumstances in which they will be used. This is especially true where existing drying methods have evolved over long periods of time to meet community and family survival needs. Alternative methods should not be recommended without awareness of all possible consequences to the farmers.

Storage losses. The extent to which deterioration and loss occurs in storage depends on physical and production factors (which have been mentioned) and on the storage environment and biological factors. In addition, physical damage to the crop during harvest may also affect storage. Undamaged cowpea pods, groundnut shells, and the husks of paddy grains afford these crops a noticeable degree of protection from infestation by most insect species, although the space these encasements occupy reduces the volume of grain that can be stored.

Storage conditions have much to do with the rate of deterioration. High temperature and humidity encourage mold formation and provide conditions favoring the rapid growth of insect populations. Deterioration is minimal in cool areas, more marked in hot, dry ones, high in cool and damp conditions, and very high in hot, damp climates. Climatic conditions during and after harvest affect the ease with which natural drying may be carried out and may dictate the need for artificial drying. Seasonal and daily changes in temperature differences between stored grains and the surrounding environment can result in movements of moisture among quantities of bulk or bag-stored grains or in condensation on the grain. Concentration of moisture can lead to conditions favorable to the development of fungi.

Some climates lessen the residual activity of certain pesticides, and can reduce the effective life of storage containers and structures. Certain structural materials may alter the effectiveness of different insecticides.

Deterioration is also related to storage methods and management. For example, cob maize stored in open-sided cribs absorbs moisture more rapidly during the rainy season than shelled maize in mud-walled cribs, so that conditions for rapid insect development are produced earlier in the storage season. On the other hand, properly designed open-sided cribs will allow relatively rapid drying of unhusked ears of maize and reduce losses due to mold. Traditional pest control methods are often effective in keeping down infestation levels. For example, some farmers storing pulses and larger grains will mix a smaller seed or sand with the grains to fill the intergranular spaces. This effectively inhibits the development of bruchid beetles. Other farmers use a fire under their storage cribs to repel insects, either through the effect of the smoke or by keeping the grain dry. The admixture or overlay of ashes derived from burning various woods or dried animal dung is another method affording protection against insect attack.

Biological factors. The principal biological agents of deterioration during storage are insects and mites, fungi, and rodents. Insect pests are a greater problem in regions where humidity is high, but temperature is the overriding factor that influences insect multiplication. At temperatures of about 32°C, the rate of multiplication is such that a monthly compound increase of 50 times the present number is theoretically possible. Thus, 50 insects at harvest could multiply to become more than 312 million after 4 months.

The nutritive requirements of insects are much the same as those of vertebrates, so that crops with the highest nutritive values for man are also those most susceptible to insect damage. Furthermore, insects often select the most valuable portion of the seeds. For example, four important maize pests attack the kernel's embryo and reject the starchy endosperm, thus removing the most nutritious part of the grain as well as destroying the power of germination. In certain cases, farmers may keep only small amounts of a nutritious crop, such as beans, because they believe damage and loss to be inevitable.

Weight loss in products has economic as well as nutritive importance and, in the absence of effective control measures, insect attack on cereal grains and beans can be extremely severe, reducing the commodity to empty husks and dust. Large numbers of insects can be expected to produce heavy weight losses, and the resulting contamination by dead and live insects and their excreta can be sufficient to make the commodity completely unpalatable and unacceptable in the market.

Control measures depend first on storage hygiene, whether or not insecticides are available. Storage containers must be checked and cleaned as carefully as possible. Old stored grain should be checked and, if necessary, redried and cleaned to control existing infestation. New dry grain should be kept separate from old stored grain because of the risk of cross-infestation. Similarly, stores should be as remote from the field as possible; it should be assumed that new grain is infested from the field. Control must include a regular system of inspection and preventive actions to maintain storage hygiene, and take counter measures where infestation is found.

Traditional pest-control systems not involving insecticides are adapted to local circumstances. Use of local herbs, mixing ash with grain, and smoking are effective measures and should be encouraged. Every effort should be made to build on traditional technology, and innovations should be undertaken with an understanding of the social and economic implications. This is particularly important in the case of insecticides that present severe health hazards or have other environmental, economic, or social implications (such as overoptimistic expectations that new technologies will solve all problems and remove the need for traditional efforts).

Many insecticides are becoming widely available in developing countries as their application is encouraged by suppliers and extension services. Some are more hazardous to humans and (potentially) to the environment than others, but all should be used with great care. Some can be used on seed grain in high concentrations that would be dangerous if used on food grain. The grain-storage insecticides are of two main types:

- Contact poisons such as dusts, dispersible powders, and emulsions. Some insecticides, such as BHC, are quite stable and have long residual action; others, like malathion, usually have little residual action and are used where human consumption of the grain precludes the use of longer-acting chemicals. Some compounds may be mixed with grain at the time of storage, while others are used for spraying storage containers or bagged grain. The level of application and its timing in relation to expected human consumption are major problems for extension services seeking to improve insect control in rural grain storage.

- Fumigants, which are gases, can penetrate bulks of grain and kill insects and their larvae living within grains. The negative factors are that all fumigants are safe only when used by trained personnel, and that they have no residual action to protect grain from subsequent reinfestation. A first requirement involves improving application methods and more careful monitoring of insecticide use to achieve maximum control of infestations. Reports of insect resistance to chemical insecticides are frequently encountered, and awareness about the drawbacks of chemical use is also increasing. As a result there has been renewed interest in traditional nonchemical control techniques, and in developing alternative approaches to pest control.

The principal non-insecticidal methods of coping with insect infestations involve: manipulation of the environment to make it less favorable to the insect; breeding resistant crop strains; using natural enemies of insects such as parasites, predators, and disease carriers; sterilizing insects to interfere with normal reproduction; and using attractants and repellants.

Some of these methods are not new techniques. Traditional methods of controlling insects in storage involve mixing sand, limestone, ash, or herbs with the grain which, in addition to forming a barrier against the movement of insects through the grain, abrade or absorb the wax coating of the insect's protective cuticle, causing a loss of body moisture. In many areas insects (and rodents) are repelled by smoke from small fires, used either within empty granaries to decontaminate them or under granaries constructed of permeable materials such as woven plant fibers. The fire also assists grain drying. In other areas, stored grain is inspected frequently and is redried in the sun if insects are observed. Hermetic storage, with grain sealed in airtight containers, is highly effective in excluding insects. However, the system is difficult to maintain for large quantities and is usually confined to relatively small amounts of seed grain.

Along with investigations of newer possibilities for nonchemical control measures, traditional methods should receive greater attention in order to increase understanding of their underlying biological basis. The knowledge gained about both approaches can form the basis of more effective and safer methods. Since the methods are dependent on manipulation of the ecology to the detriment of insects, they are highly location-specific, which increases the need for research and adaptation of techniques to local circumstances. This will require long-term study, making it unlikely that there will be alternatives to replace or greatly reduce insecticide use in the near future.

Fungi attack grain in storage when the drying has been inadequate, when large numbers of insects are present causing a temperature rise in the grain, or when the stored crop is exposed to high humidity or actual wetting. Fungal development does not normally take place when the moisture content of the commodity is below the moisture content of the environment at a relative humidity of 70 percent. Fungi penetrate the endosperm of grains, removing the nutrients. In many cases the embryo is attacked first and eventually destroyed. Fungal spoilage is more serious in those regions with a permanent high humidity, or where a season of high humidity coincides with the time when grain is dried or stored. Microoranisms may multiply and create heat that can increase in unventilated stores sufficiently to completely destroy the grain. However, losses due to fungi are reduced by improvements in drying and storage technology, and do not need to be treated separately.

Rodent damage to stored food can occur in a number of ways. The animals not only consume the food (damage to maize grains is characteristic in that the embryo is usually removed first), but also foul a large amount with their excretions (which may carry microorganisms harmful to man), destroy containers by gnawing holes that result in leakage and wastage of grain, and paw into and scatter grain while they eat. This scattered grain, along with that which leaks from gnawed holes, is subject to contamination. Damage to grain stored in bulk may be much less than to grain stored in bags because rodents are unable to burrow into the bulk.

These problems have recently been reviewed in a report prepared by the U.K. Centre for Overseas Pest Research and the Tropical Products Institute. This report analyzes extensive information provided by a number of governments. It concludes that in most countries very little is known about the extent of the problem, although some countries with high losses, such as India, have considerable expertise in this area and allocate large resources to the control of rodents. Techniques for rodent control fall into the following broad categories:

- Rodent exclusion efforts in store construction;
- Improved sanitation, which includes removing food and harborage from the surroundings or reducing it as much as possible.
- Poison baiting, including use of the anticoagulants such as chlorophacinone, warfarin, coumarin, diphacinone, and coumatetralyl, and acute poisons such as zinc phosphide, barium carbonate, red squill, and vacor;
- Fumigation with phosphine or other gas;
- Trapping and hunting;
- Use of cats and dogs; and
- Rodent repellents.

Estimates of the effectiveness of these techniques are mixed; experience is sometimes contradictory even within the same country. Results depend on the thoroughness with which the control technique is applied and the length of time it operates. Control usually is more effective when a combination of methods is used, particularly those that prevent access to food. The persistence of the rodent problem is obvious in a report from Israel where it is fully recognized and control is vigorous and well organized, but where the estimated loss to crops in the field remains at 5 percent. It should be recognized that store rodents cannot be eliminated unless field rodents are also controlled.

Observations from the People's Republic of China indicate that well-organized rodent exclusion, together with sanitation and field control, may have been rather successful, although no published figures are available. Traditional and modern granaries are reported to be protected by detailed attention to cleanliness, by physically isolating the granary, by laying concrete on the area around and underneath the granary, and by providing rat barriers at points of potential access.

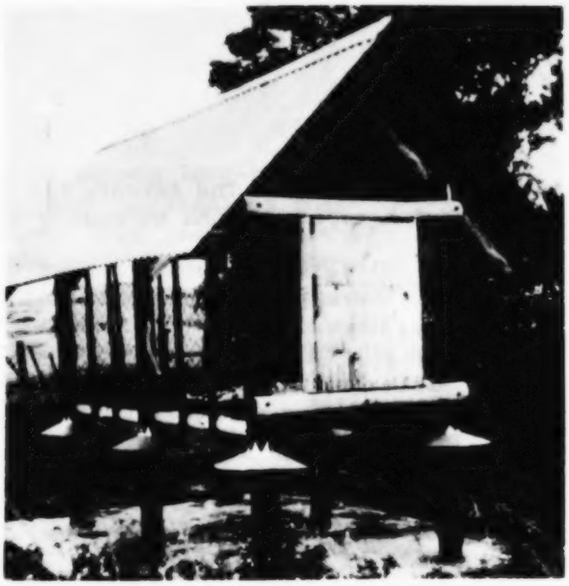
New rodent-control technologies, even simple ones, may meet considerable resistance at the farm and village level. For instance, local acceptance of baffles fitted to traditional storage containers has been slow, at best. In this and similar cases, more research may be needed to determine whether such unpopular solutions to problems are the most effective. There are also reports that rodents are becoming resistant to rodenticides, although there is little evidence of this from tropical regions, which indicates that research on this subject is also desirable.

Although many countries fully recognize the seriousness of food loss caused by rodents the editors of the report of the Centre for Overseas Pest Research conclude that "the one single fact which emerges most clearly from the survey is the widespread ignorance of the magnitude of the rodent problem, and of means to control it."

We have discussed the physical, environmental, and biological causes of grain losses during storage. Now we will turn to the methods of reducing storage losses, including a brief description of traditional and innovative storage practices.

## Reduction of Storage Losses

In developing countries, storage on the farm is an important part of the traditional farming system, both in the subsistence sector and the semisubsistence or farm-to-village market sector. It is essential both for conserving seed for the next planting and for stockpiling

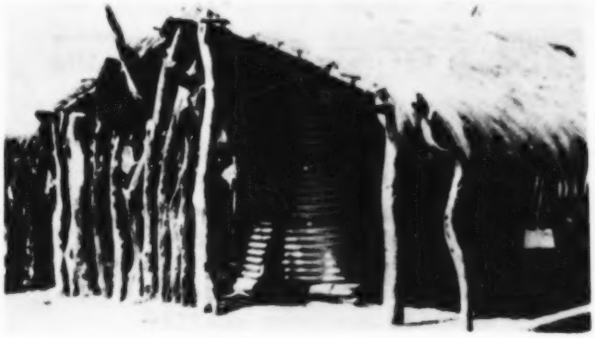


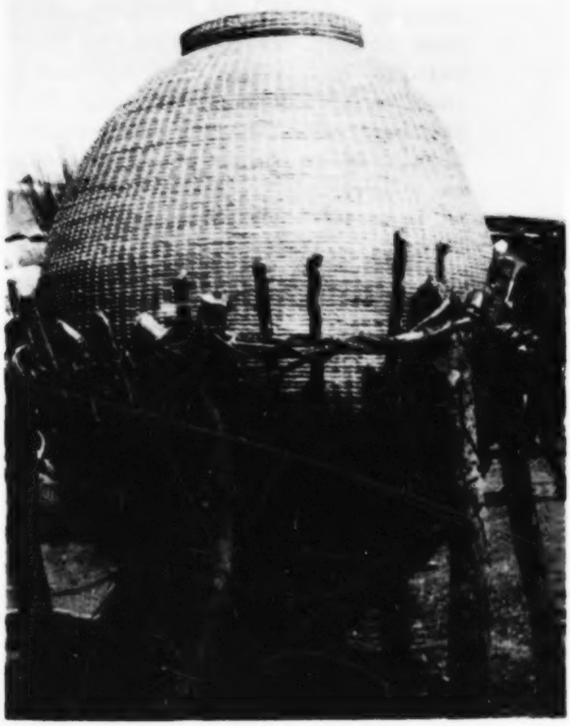
Above: Recommended mesh-sided crib, Swaziland, with corrugated iron roof and metal rat baffles.

Below: Grain storage basket, northern Ivory Coast.

Above: Traditional storage houses, Laos.

Below: 1-2 tonne metal grain tank, Swaziland, raised from ground and sheltered from rain.





staples to feed the farmer, his family, and his livestock until the next harvest. Sound storage practice has three elements:

1) Proper preparation of the grain for storage, including drying and, where possible, separating out any infested or spoiled grain and other impurities; 2) Sound storage structures that provide protection from moisture (rain and ground moisture) or excessive drying, and a barrier against insect and rodent pests; and 3) An appropriate system of monitoring the quality of the stored grain and treating and handling it while it is in the store.

Traditional storage practices. Traditional systems have evolved over long periods of time to satisfy storage requirements within the limits of the local culture. Grain for seed is frequently sealed in gourds or clay containers and kept in the house. Larger amounts of grain for human and animal consumption are stored in containers constructed of plant material, mud, or stones, often raised off the ground on platforms and protected from the weather by roofing material. The design and materials vary according to local resources and custom.

These traditional grain storage systems may provide reasonable storage security for the traditional farmer, but this does not mean that losses are necessarily low. With the exception of sealed containers (including underground pit stores in drier areas that control insects by limiting the supply of oxygen), the traditional structures provide only limited protection against insect and rodent damage, particularly in areas where the climate is warm and humid or where grain is stored for extended periods. Nevertheless, it does mean that there is less risk of large-scale losses under traditional decentralized storage systems.

Subsistence or traditional farming systems are being improved by the introduction of high-yielding varieties of grain, which farmers are encouraged to grow. However, as a consequence of increased production the traditional storage system is proving inadequate not only in capacity, but also in protecting grain from damage, since the new varieties may be more susceptible to insect attack.

There are three approaches to solving traditional storage system problems:

- Improving small-scale on-farm storage;
- Centralizing grain storage with efficient collection, drying, and large-scale stores; and
- Breeding new varieties of crops that are less susceptible to storage loss.

Of these approaches, the last two are important long-term possibilities with political, social, and economic implications that are largely outside the scope of this report. They will require expanded research efforts, particularly on the socioeconomic aspects of centralizing storage.

New on-farm storage practices. In recent years, this aspect of postharvest technology has been receiving considerable attention. In East Africa, adaptations have been made to the traditional design, for example, by fitting "rodent baffles" (Kenya and Malawi) or mud-plastering cribs for the storage of shelled grain (Zambia and Malawi).

In Guatemala, India, and Swaziland, prefabricated corrugated or plain (flat) metal storage tanks have been in use for a number of years. These tanks permit fumigation of the grain with hydrogen phosphite tablets, reduce the probability of reinfestation by insects and rodents, and reduce the rate of moisture absorption. By 1976, at least 40 percent of Swaziland farmers were using them.

Introduction of improved grain bins has not met with the same success in Ghana and Zambia, where concrete stores proved unacceptable to farmers because of rising costs, material shortages, and difficulties in construction. A more recent approach, adopted in Zambia, is to produce a cheap, easy-to-construct container using readily available materials. The container, known as the "ferrumbu," incorporates the features necessary for safe grain storage and should be affordable by emergent commercial farmers.

In Southeast Asia, metal storage containers have been introduced on a fairly wide scale. Problems have been encountered, however, with drying rice adequately before storage, providing sufficient ventilation, and preventing stored rice from absorbing moisture from the humid atmosphere. Solutions to these problems are considered essential in reducing losses of stored rice in Southeast Asia.

Small-scale on-farm grain storage technologies have been compiled by Lindblad and Druben in the Peace Corps-VITA manual mentioned above, which has been made widely available to developing countries. The Lindblad-Druben manual includes discussion of the advantages, disadvantages, and construction instructions of various grain-storage methods, [some of which are shown on pp. 110-19 below].

- Traditional basket storage;
- Bagged storage;
- Airtight storage-underground pits, including "Thailo" (ferrocement-lined traditional Thai grain silo), plastic sack storage, metal drums and bins, and sheet metal silos;
- Earthen structures-mud brick silos; and
- Cement and concrete structures--cement stave silos and village concrete silos.

Losses during processing. Primary processing losses occur during threshing and milling; parboiling; or further processing, e.g., baking, canning, etc.--outside the focus of this study.

There is a tendency for processing losses to increase as larger amounts of a crop are produced and strain the capacity of a traditional processing system. Maize normally shelled by hand, for example, may be placed in sacks and pounded with a stick to detach the grains from the cob. Mechanical processing is generally less efficient than manual processing, both because it is incomplete and because of damage to grains due to their variations in size or poor adjustment of the machinery. Manual processing efficiency may be used as the standard against which the efficiency of machinery is measured.

In many societies central milling facilities process grain brought in by farmers for a price determined by the initial unmilled volume or weight, and there is thus little incentive for mill operators to reduce subsequent losses due to poorly adjusted equipment or leakage and spillage. Payment may also be in kind, with part of the milled product or the milling by-products going to the miller.

Attitudes towards broken grains vary from society to society; acceptability of off-color grain due to poor parboiling or drying varies. In many cases, this simply means that the poorer members of society have the broken grains and dust, or otherwise lower-quality grain, and there is little economic loss to the producer. In Pakistan, the Council on Scientific and Industrial Research has experimented with reconstituting "whole" rice grains from broken grain and rice powder, with favorable consumer response.

## Conclusions

Implementation of the United Nations Resolution on 50 percent food loss reduction will require substantial resources including, in particular, trained men and women. We believe that available information justifies worldwide expansion of current efforts, directed particularly toward helping developing countries to establish their own postharvest loss-reduction policies and programs. The current level of international effort expended for estimating and reducing losses is hard to quantify, since few organizations and programs are limited to, or clearly identified by a concern for postharvest loss activities. It is also difficult to disaggregate expenditures on storage, for example, from national agriculture budgets, or large agricultural development loans. But there is general agreement among knowledgeable observers that, with a few notable exceptions, the overall level of effort directed to postharvest losses is inadequate compared with both agricultural production activities and the potential savings of food.

There are many reasons for the inadequate attention paid to the postharvest system, differing from country to country. Among the more important reasons for this neglect is the lack of professional identity and opportunity for career employment, which in turn reflects the limited attention and money allocated to the problem. In part, this is because the high costs and environmental consequences of continued expansion of production have only recently made postharvest food conservation an obvious alternative. Further, the cost effectiveness of postharvest loss reduction has not been demonstrated on a broad scale. Nevertheless, loss reduction through "sound conservation practice," involving actions that use relatively small increments of time and money, is a reasonable way to protect the greater investment of labor, capital, and other inputs already committed to food production.

[Extracted from a study by a Committee on Postharvest Food Losses in Developing Countries. Published by the National Academy of Sciences, 1978.]

Copies of this study, which also covers materials on preserving perishable foods and fish, can be obtained by writing: National Academy of Sciences, 2101 Constitution Avenue, N.W., JH-214, Washington, D.C. 20418, USA.

# Storage Techniques for Villages

Carl Lindblad and Laurel Druben

[The following extracts are from a manual on Small Farm Grain Storage, used by VITA and the U.S. Peace Corps to instruct people who are dealing directly with villagers. It contains specific directions for users of these techniques (much more detail than is shown here). What follows takes up basket granaries, airtight storage in plastic bags, metal storage including oil drums, and a design for a mud-block storage bin.]

Storing grain in basket granaries. Grain has been stored in basket-like containers made of grass, reeds, bamboo strips, or small branches for thousands of years. The particular building material depends upon the plants available near a farmer. These basket granaries are so traditional and widely used that it does not seem necessary to include a plan for making them. There are almost as many different kinds of baskets as there are villages making them, and the skills for this kind of work are passed on within families. What this manual will present is some suggestions for improving basket granaries so that grain stored in them is more protected from insects and molds.

To increase the protection of grain kept in baskets:

- Keep the basket off the ground. Make a strong platform upon which the basket can sit. The shape of the platform will depend upon the shape of the basket. Putting the basket on a platform prevents moisture from coming through the ground into the basket. The platform also offers more protection from rodents.

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- Make sure the basket is well protected from the rain. If it is a grass or reed basket, keep it in the house or some other dry building.

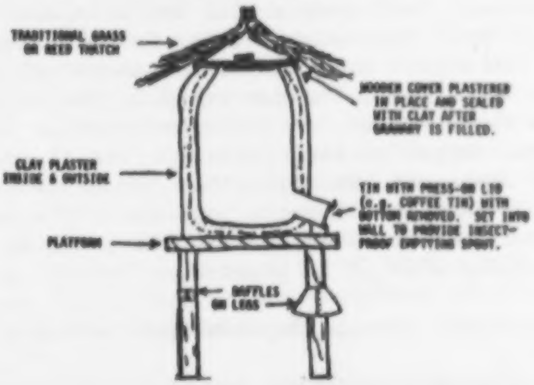
- If it is woven of material which can be kept outside, make sure the roof thatch does not let any rain into the grain.

- Place rodent baffles (guards) on the legs of platforms which support the baskets. These prevent rodents from climbing or jumping into the baskets. (The rodent proofing section contains information on making rat baffles.)

- A tin can, with a plastic cover that can be put on and taken off easily, makes a good emptying chute (see the picture below). Cut the bottom out of the can and fit the open end of the can into the lower part of the basket. This makes it unnecessary to take off the cover each time grain is taken out.

- Baskets can be plastered inside and outside with mud, clay, or cow dung. Covers should be tight and sealed with plaster of the same material. It is important for farmers to realize that grain holding a lot of moisture, whether threshed or freshly harvested, should not be placed in baskets which have been plastered in this way. Plastering makes the basket much more airtight. Moist grain needs to have air passing through to dry it. If moist grain is put into storage without enough air, it will mold and rot quickly.

IMPROVED GRANARY


TRADITIONAL GRASS OR REED THATCH
WOODEN COVER PLASTERED IN PLACE AND SEALED WITH CLAY AFTER GRANARY IS FILLED.
CLAY PLASTER INSIDE & OUTSIDE
TIN WITH PRESS-ON LID (e.g. COFFEE TIN) WITH BOTTOM REMOVED. SET INTO WALL TO PROVIDE INSECT-PROOF EMPTYING SPOUT.
PLATFORM
BAFFLES ON LEGS

## Airtight Storage

Insects can still grow and reproduce in very dry grain. Grain dried to a 12 or 13% moisture level will not mold, but can still be very good food for insects. The moisture level in grain has to be 9% or less to slow down insect development. Very high and very low temperatures also slow down insect growth. But most farmers will have trouble getting their grain below 12% moisture and in using temperature to control insect development. They often do not have the special equipment necessary to do these things.

More and more farmers do use insecticides to control insects in grain. But some insecticides are dangerous; some are expensive; sometimes they are not available; and there is increasing concern about using chemicals of any kind on food products.

How it works. Airtight storage simply means putting grain into containers which keep air from getting into the grain. Some air is let into the container at the time the grain is put into storage. But after the container is sealed, no more air enters. The respiration of the grain and any insects in it uses up all the oxygen. Insects need oxygen to live. They die without it. Any molds present which require oxygen also will die.

You can show farmers how airtight storage works by putting some insects and grains on a very smooth surface and turning a glass over on top of them. Make sure the glass is tight against the surface. Seal it with wax or some other material. Or seal some grain kernels and insects in a glass jar. Cover the jar with a screw-on lid or a plastic sheet. Just make sure no air can enter the container.

Wait for a while. The insects will begin to move more slowly. Finally, they will die. How long it takes for the insects to die will depend upon the number of insects, the amount of grain, and the size of the glass container. You can speed up the experiment by placing a lighted candle under the glass container. The flame on the candle requires oxygen to keep burning. The flame will use up the oxygen in the container quickly. When the oxygen is gone, the flame will go out. Soon, the insects will die. The lack of oxygen, which kills insects does not seem to hurt the grain or to keep seed grain from germinating when it is planted.

Successful airtight storage depends upon a number of things:

- Building containers which are airtight. This means using materials which do not let air flow through them, for example, metal, plastic, concrete. These containers must be checked to make sure there are no cracks or holes. Sometimes a farmer will see light coming through cracks in a large container. If the container is a gourd, for example, he can check for cracks by filling it with water to see if there are any leaks. All cracks in storage containers should be sealed for good protection. In addition, it is usually a good idea to coat or paint the entire outside (and sometimes the inside) surface of the container with tar or oil-based paints (they are waterproof and also do not let air pass through). For a farmer who cannot afford to buy these materials, there may be local trees and plants which produce materials useful for waterproofing.

- Sealing tightly the holes for putting grain into the container and for taking grain out. Tar, wax, or pieces of rubber cut from old tires and inner tubes can be used for this.

- Filling airtight storage containers to the top is important. Full containers, which are sealed against air, can kill insects in a few days. But if the container is not full, the insects take a lot longer to die. And before they die, they may damage a lot of grain.

- Keeping the storage container closed. Unless the airtight container is quite small, farmers probably will want to store the grain they use for food separately. The storage container holding the food grain is opened often. Every time a container is opened, more air containing oxygen enters the stored grain. This added air and frequent opening encourages insect growth.

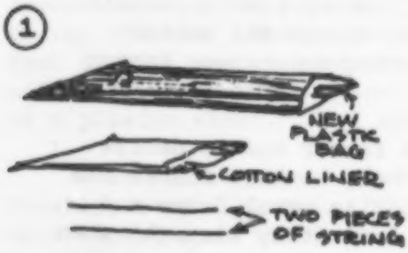
Choosing a method of airtight storage. A farmer has to decide what he needs his storage method to do, and, then, he must figure the costs of each method. Some of the methods, such as metal drums and plastic sacks, cost more money. But they are definitely airtight when used correctly and are very likely to make up their costs by good storage of grain. Other methods, such as the Improved Mudblock Silo, are hard to make airtight, take longer to build, and require more upkeep. But they can hold large amounts of grain, and they can be made with local materials. Airtight storage is something farmers who store dry grain should work toward. (REMEMBER: IF THE FARMER IS STORING GRAIN WHICH HAS A MOISTURE CONTENT OVER 12-13%, HE SHOULD NOT USE AIRTIGHT STORAGE. Grain which has a high moisture content should be stored so that air can pass over the kernels.)

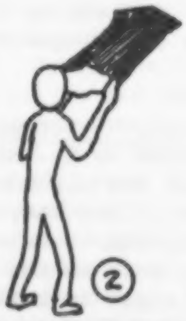
Storing grain in plastic sacks. Plastic bags make good airtight storage containers:

- Use plastic bags which are .20 to .25mm thick (500-700 gauge).
- Make sure there are no holes in the plastic. Even the small-

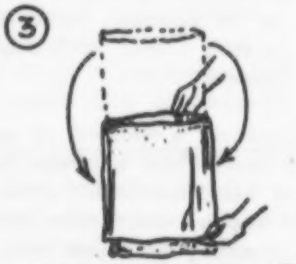
est hole will cause problems.
- Some insects can puncture plastic when trying to escape from the sack. But this can be stopped by putting a cloth bag of tightly woven cotton inside the plastic bag. The cloth is added protection.
- Use grain which is very dry.
- Add insecticide to the grain. It can take a week or more for insects to use up the oxygen which is in the bag.
- Fill the sacks and seal them tightly.
- Store the filled bags off the ground on a smooth surface so that they will not be punctured by the floor or anything sharp.

| | |
|---|---|
| Advantages: | Plastic bags are easy to store.<br>Plastic bags are easy to move around.<br>They provide good protection against insects.<br>Plastic bags make good containers for fumigating small quantities of grain. |
| Disadvantages: | Plastic can be torn or punctured easily.<br>They are generally good for only one year and must be replaced after that because small holes have been made in them.<br>Rodents can eat through plastic.<br>Plastic bags are expensive in some areas. |

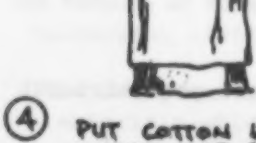




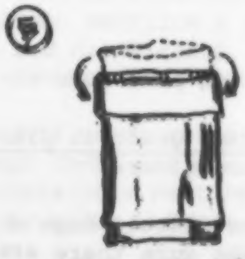
MAKE SURE THERE ARE NO HOLES IN THE BAG.



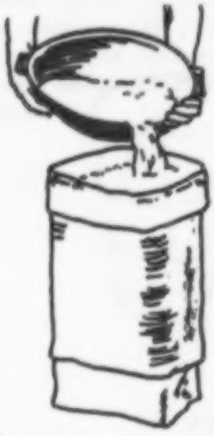
FOLD BACK TOP OF PLASTIC BAG.



PUT COTTON LINER INSIDE THE PLASTIC BAG.

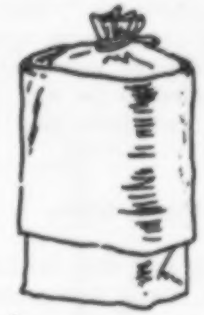


THEN FOLD THE TOP OF COTTON BAG OVER THE PLASTIC BAG.



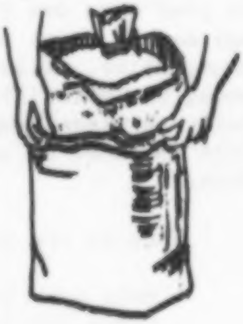
⑥ ALMOST FILL UP WITH GRAIN.

⑦ FOLD THE COTTON BAG OVER THE TOP OF THE GRAIN. TIE WITH A STRING.

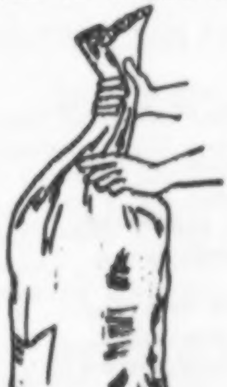


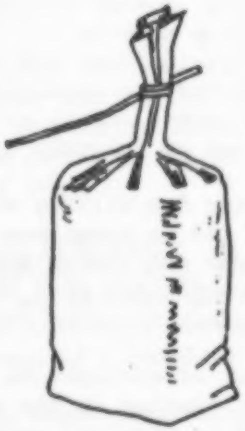
(MAKE SURE THERE ARE NO SEEDS BETWEEN LINER AND PLASTIC BAG.)

⑧ DRAW BACK THE PLASTIC CUFF

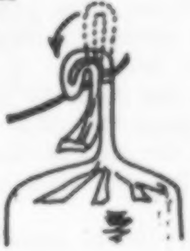


⑨ SQUEEZE PLASTIC TIGHTLY ABOVE THE TIED COTTON BAG TO PRESS AIR OUT.

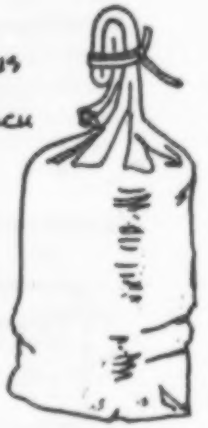




⑩ DOUBLE TIE IT.



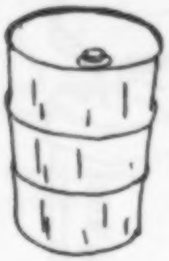
⑪ FOLD UP THE SURPLUS PLASTIC AND THEN BEND THE FOLD BACK ON ITSELF.



⑫ TIE THE TWO HALVES OF THE FOLD TIGHTLY TO GETHER.

## Storing Grain in Metal Drums

In many parts of the world, 220-litre drums are available and not too expensive. If farmers in your area can find oil drums, this is a storage method which may be a good investment. Sorghum, maize, millet, cowpeas, and groundnuts are among the materials which can be stored successfully in these drums. The grain should be dry (12% moisture or less) when it is put into the drum.



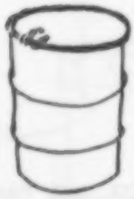
Here is the procedure for using a drum:

- Make sure the drum is clean and dry inside.
- Check for holes. Holes in these drums can be plugged with wax.
- Pour clean, dry grain into the drum through the small top opening. Use a wide-mouth funnel to help with this job.
- Shake the drum to let the grain settle; then fill it again.
- Make sure the drum is full.
- Screw the cap on tightly. If the rubber ring on the inside of the cap is missing, smear the cap with grease.

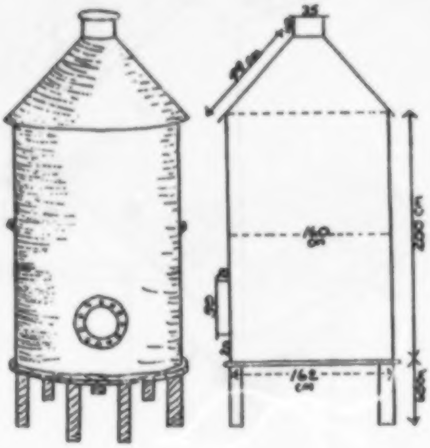
Each drum holds about 660 kg of grain.

Advantages: Provides good airtight storage control of insects.
Protects the grain from rodents.
Works well for seed grain; does not seem to hurt the ability of the seed to germinate.
Is available in most areas and is not expensive.
Makes a good container to fumigate grain in.

Disadvantages: Has a small opening for filling and emptying.
Special clamp-on lid is sometimes available, but this lid does not create airtight conditions and insecticides must be used.
Works best when grain is being stored 5 months or more.
Has to be kept out of sunlight to prevent moisture changes and heating in the stored grain.
Can rust and must be repaired carefully for airtight storage to be continued.



**Sheet metal silo.** This silo was developed by the Institute of Tropical Agriculture Research in Benin (formerly, Dahomey), Africa. It is a good example of an easily made metal storage container. The model below is made of sheet metal, 1mm thick, welded together at the seams. It has two openings, one for filling at the top of the bin and one for emptying at the bottom. The cost of the 3 ton model shown here is about $175 (U.S. currency) when manufactured in small numbers.



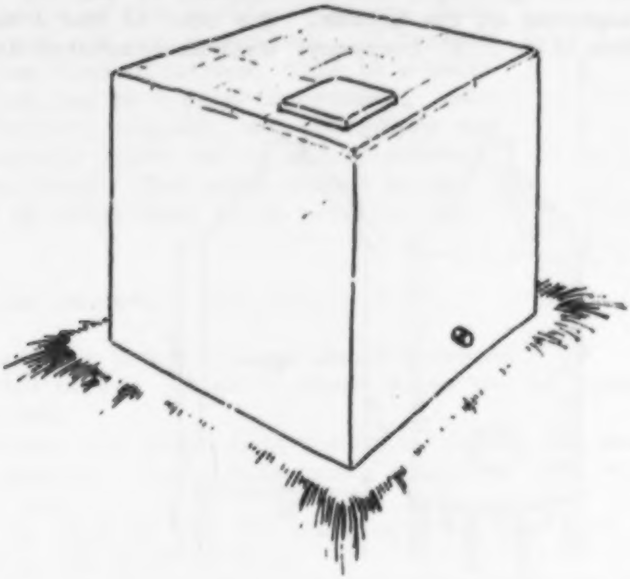
## The Indian Pusa Bin

The Pusa Bin was developed in India by members of the Agricultural Research Institute in New Delhi. It is made of mud bricks, covered inside and outside with a smooth coating of mud or mortar. It is relatively simple and inexpensive to construct and maintain. This bin is double-walled all the way round--including the floor and roof--with a layer of plastic sheet between the inside and outside walls. The plastic protects against moisture and keeps air from entering the stored grain.

Protect the bin from rain. If the bin is not erected under a shed and it rains often, it will require too much repair and rebuilding, and the grain may get wet and mold. However, complete shading from the sun is not necessary because mud walls do not hold heat. This is one advantage of a mudblock structure over a metal bin.

In India, rats cause great storage losses. For this reason, the bottom 50 cm of the outside wall and the first layer of the floor slab are made of fired, or "burned," bricks. These bricks are harder than un-fired bricks, like mudblocks, and rats and mice cannot gnaw through the bin walls or burrow up underneath the floor to get to the grain. Another way to keep out rats and mice is to use sheet metal over whatever kind of non-hardened material you use, in the same places.

## THE INDIAN PUSA BIN



This plan is for a 2 metric ton bin. You may vary the size of the bin to fit your needs. The plan uses an insulating layer of plastic sheet. The Pusa Bin is airtight and waterproof only if the plastic sheet is made and used correctly. The plastic sheet used should be at least 700-gauge thickness, to resist tears and punctures. If plastic sheet is not available or if it is too expensive, some other form of waterproofing will be needed in warm rainy areas. Check out what is available locally. Tarfelt--heavy paper impregnated with tar --can be used. Experiment with bricks containing cement. Try painting the bin with asphalt, coal tar or any other local waterproofing substance. Remember, the bottom of the bin must be waterproofed to stop migration (seeping of moisture from the earth below).

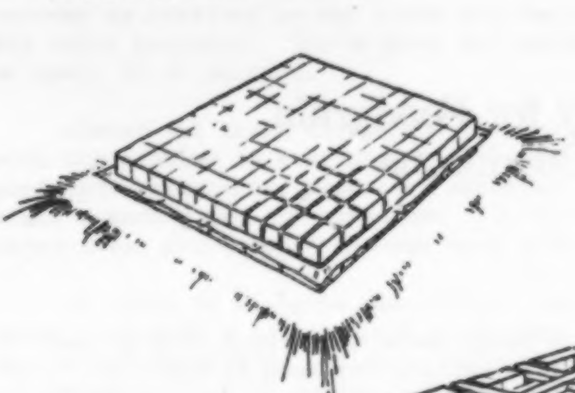
[Extracted from Volume III, "Storage Methods," of Small Farm Grain Storage, published by Volunteers in Technical Assistance (VITA), Washington, D.C. First printing 1976.]

The three volumes of Small Farm Grain Storage entitled "Preparing Grain for Storage," "Enemies of Stored Grain," and "Storage Methods" can be obtained for use. For information write to Stephen Clark, VITA, 3706 Rhode Island Ave., Mt. Rainier, MD, 20822, U.S.A.

# BUILDING THE PUSA BIN

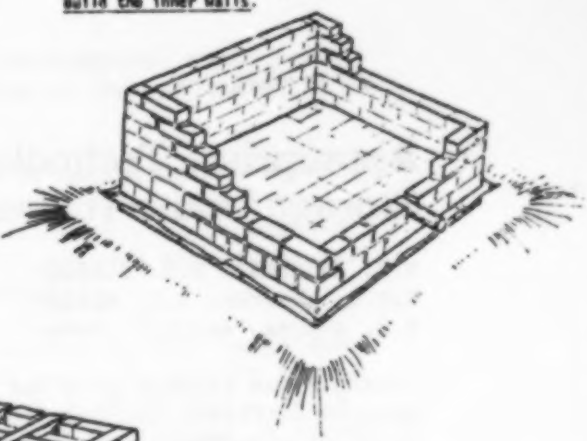
(1)

Lay down a layer of mudblocks and mortar on top of the plastic, the same size as the first brick layer.

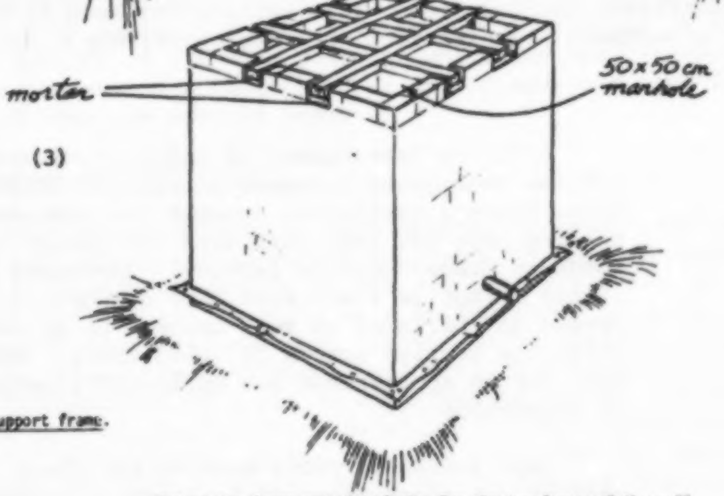


(2)

Build the inner walls.



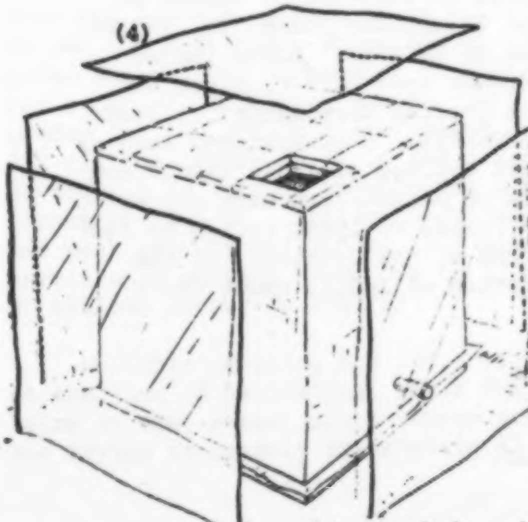
(3)



Install a roof support frame.

Mortar the frame and the blocks for the top layer of the wall into place. Make a smooth top surface on the walls.

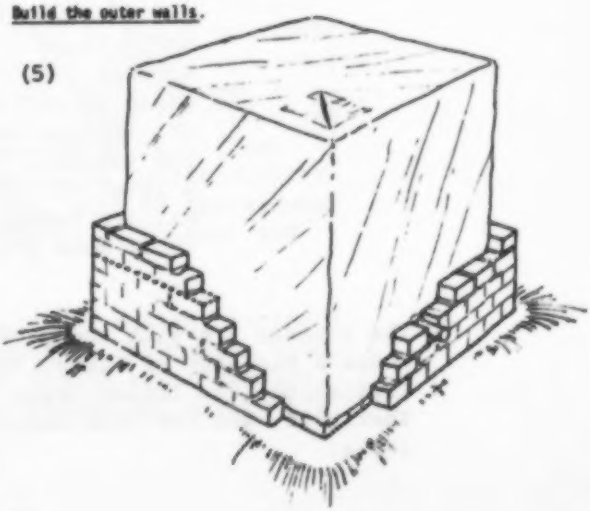
(4)



Join the darkened edges of the plastic sheets

Build the outer walls.

(5)



# Appropriate Technology for Foodgrain Storage Under Indian Conditions

N.S. Aggarwal, B.R. Birewar,
K.K.S. Chauhan, G.K. Girish,
S.N. Sharma, and B.K. Verma

[India faces storage problems on a large scale at various levels, requiring different technologies. This article focusses on choices faced by government organizations handling relatively large volumes of grain.]

With the development of Indian farm technology and the consequent increase in agricultural production, storage facilities created for subsistence farming have not kept pace with the changes brought about by commercialized farming. Increased productivity cannot be translated into a proportionate increase in the level of real incomes in an economy in which the storage system is inefficient. Hence, the need for an appropriate and efficient storage system is imperative.

Food grains in India account for about 75 percent of the gross cropped area. Their production over the last 28 years has shown a significant increase, achieving a level of 125 million tonnes in 1977/78 from a level of 52 million tonnes in 1967/68 and 28.8 million tonnes in 1949/50. Since Indian agriculture largely depends upon agro-climatic and monsoon conditions, the precise forecasting of food grain production is difficult. Organizations such as the Administrative Staff College of India (ASCI) and the National Commission on Agriculture have projected a level of 164 million tonnes by 1985, rising to 230 million tonnes by the end of the century. Of the total food grain production of India, about 60-70

The authors are with the government of India's Ministry of Agriculture and Irrigation, the Indian Grain Storage Institute, and the Food Corporation of India.

percent is retained on the farms for family consumption, seed, feed and other purposes. The surplus for marketing is thus estimated to be about 30-40 percent.

Almost all those engaged in the process of marketing are faced with the problem of storage. The various storage agencies are the producers, merchants, transport agencies, warehouses, the public and state agencies and the consumers. In view of the wide variations in objectives, problems of storage vary significantly.

In terms of absolute quantities, farm storage is very large compared with both trade and public storage, and was even greater before the Second World War. Private trade also plays a major role. It is estimated that 70-75 percent of the marketable grain surplus is stored by traders for periods of time and purposes which may vary from place to place. Nevertheless, the facilities of public agencies have increased fourfold over the last 15 years.

## Government Programs and Policies

The main food policy objectives have been as follows: (a) To stabilize consumer prices and safeguard interests of the low-income consumers; (b) To ensure reasonable prices and incentives for increasing production; and (c) To build up a buffer stock of grain as a safeguard against shortages and high prices, or to support falling prices. Measures along the following lines have been taken from time to time: (a) Introduction of a public distribution system for the acquisition and sale of stocks; (b) Regulations to curb speculation and hoarding; (c) Restrictions on the movement of grain; (d) Regulation of bank advances against grain; (e) A ban on forward trading.

The quantity of food grain distributed through government channels has averaged more than 10 million tonnes per annum. A network of 240,000 fair-price shops serves 566 million people in rural and urban areas. The Government of India has decided to build up a buffer stock of 12 million tonnes, over and above the operational stocks needed for the public distribution system, which range between 3.5-3.8 million tonnes in April and 8.2-8.8 million tonnes in July. The Government is further considering a buffer reserve of 14 million tonnes by 1982/83. Storage requirements to maintain buffer reserves and peak operational stocks of 9 million tonnes, with an operational margin of 8 percent, work out to 23 million tonnes at present and 25 million tonnes by 1982/83.

Multiple cropping has led to a higher moisture content in grain at the time of harvesting, while the coincidence of harvesting with rains in some areas causes severe problems in drying and threshing. Sun drying is largely resorted to at present; mechanical dryers are used occasionally. Grain is currently handled manually; to keep pace with the increases, efforts are being made to introduce mechanical handling.

Various loss estimates have been made. The Government of India Expert Committee on Post-harvest Losses (1967) estimated that foodgrain losses at various stages account for 9.33 percent of production. Storage loss was put at 6.58 percent, and threshing, transport and processing losses at 1.68 percent, 0.15 percent and 0.92 percent, respectively. Various agencies have estimated grain losses due to different factors as reflected in Table 1.

TABLE 1. ESTIMATED GRAIN LOSSES
(Percentage)

| | *Source of estimate* | | | | |
|---|---|---|---|---|---|
| | | *ASCI and public agencies* | | | |
| *Cause of loss* | *Expert Committee* | *Farm level* | *Trade* | *Conventional godowns* | *Silos* |
| Insects | 2.55 | 3–4 | 3–4 | 0.5–1.0 | 0.5 |
| Rodents | 2.50 | 0.5–1.0 | 0.3–1.02 | – | – |
| Birds | 0.85 | – | 0.2 | 0.2 | – |
| Moisture | 0.68 | – | 0.2 | 0.2 | 0.2 |
| Other | – | – | 0.3 | 0.3 | – |
| Total | 6.58 | 5.0 | 5.0 | 2.0 | 1.0 |

*Sources:* Interim Report of the Government of India Expert Committee on Post-harvest Losses; Administrative Staff College of India

## Government Programs to Minimize Farm Losses

The upward trend in the production of food grains will continue to affect farmers' post-harvest losses. The Department of Food launched a "Save Grain Campaign" during 1965/66 as a pilot project, and from 1969 to 1970 as a regular plan. The Indian Grain Storage Institute (IGSI) at Hapur, Uttar Pradesh, and its field stations at Bapatla (Andhra Pradesh) and Ludhiana (Punjab) are engaged in R and D work. The objectives of IGSI include improved storage structures, coordination of all storage research, training in handling and storage, and orientation and review programs.

Designs of various metallic, non-metallic, indoor, outdoor, underground and partly underground bins have been developed, as well as improvements of existing structures of simple design, and the use of discarded coal-tar drums. In a collaborative program, data have been collected on losses, regional insect distribution, field infestation, and the quality of grain marketed. Extension programs are being carried out with the help of 11 offices in different parts of the country as part of the "Save Grain Campaign." Six more offices will soon start functioning. The aims are as follows:

(a) To train farmers, traders and extension officers in improved methods of grain storage and preservation;
(b) To extend scientific techniques through demonstration and publicity, and develop model villages;
(c) To arrange credit facilities for farmers to buy improved storage structures;
(d) To maintain liaison with state governments, and to arrange for a steady supply of storage structures and pesticides.

Under the Save Grain Campaign, within the framework of the fifth five-year plan up to March 1978, 9,380 farmers have had stipendiary training programs and 71,344 volunteers have had shorter courses. There have been 108,349 grain fumigations, 3,921,812 rat burrow fumigations, 293,166 domestic rodent control operations and 166,850 prophylactic treatments, in addition to 589 radio talks, 62 television programs, 1,101 press reports, 783 exhibitions, 1,494 film shows, and 62,349 stencilled slogans. In addition, 60,390 leaflets containing advice have been given to farmers. The designs developed at IGSI are in demand in other developing countries.

The state governments of Andhra Pradesh, Haryana, Uttar Pradesh and West Bengal are being provided with financial assistance to set up their own Save Grain Campaign teams. In addition 100 Farmers Training Centers have been included in a program to promote scientific storage. The Department of Food is meeting the cost of appointing a woman demonstrator at each center to work in nearby villages to educate women, training the instructional staff of the centers and supplying pesticides and publicity equipment.

## Food Grain Storage by Public Agencies

Public agencies are responsible for procurement, transportation, storage and distribution of grain, especially wheat and rice. Storage is necessary to regulate supply and prices. The total capacity owned by the Food Corporation of India (FCI), the Central Warehousing Corporation (CWC) and the State Warehousing Corporation (SWC) increased from 2.5 million tonnes in 1965/66 to 917 million tonnes in 1977/78. Moreover, only 60 percent of the total storage capacities of CWC and SWC are utilized for grain.

After the creation of FCI in 1965 and its gradual take-over of all storage accomodation from the Government by 1969, public agencies constructed new facilities to meet the growing demand. FCI launched successive crash construction programs, and other agencies followed suit. However, the growth pattern and investments have not matched demand in the past decade or so. In the absence of adequate covered storage capacity, FCI resorted to large-scale open storage popularly known as cover and plinth (CAP). This type of storage, a new and cheap technique, was a landmark in technology developed by FCI.

Types of storage facilities. In India, food grains are handled, transported and stored in bags. Accordingly, the entire marketing and storage facilities are geared to the bag handling system alone. Bulk-storage facilities constitute a very small fraction of the total available in the public sector. Existing infrastructure facilities, cheap labor, marketing, handling, transportation and storage facilities have been factors inhibiting the adoption of the advanced technology of bulk storage. Though it has been realized that bulk storage in vertical silos has advantages, the system has not yet gained wide popularity. Only since the early 1970s has modern storage technology received some impetus through the setting-up of vertical reinforced concrete silos at selected centers.

The conventional godown ["godown" is the Indian word for a storage shed or warehouse] is a rectangular rodent-proof structure known as a "flat warehouse" in Western terminology. The standard basic unit has a capacity of 5,000 t. Depot complexes made up of these units are generally designed to conform to the configuration of the land area and the needs of road and rail inflows. Designed for bag storage, they provide considerable flexibility for different grains and other commodities, and are accessible to any means of transport. All handling operations are manual.

The dimensions of a typical godown are 21.8 m X 127.6 m X 6.35 m. The design makes it weather-proof, gas-tight (for fumigation), rodent-and-bird-proof, and impermeable to subsoil moisture. Provision is made for natural aeration. The floor is designed for a peak load factor of quintal bags stacked 22 high.

Bulk storage structures include steel silos, reinforced concrete circular and hexagonal bins, and reinforced concrete vertical silos. Steel silos are now considered obsolete in view of their high requirements of scarce steel.

The reinforced concrete circular bins have a capacity of around 4,000 t, are circular in shape, and are constructed on a platform 3½ ft. (1.1m) above the ground. The diameter is 77-1/3 ft. (23.6m) and the side walls are 35 ft. (10.7m) high. The roof is domed, and the flooring, also of reinforced cement-concrete, is laid to slope over 3 in. (75mm) of lean concrete in the proportion of 1.5:10. A layer of 700-gauge polythene is sandwiched between the lean concrete and the sand filling underneath. Grain feeding is by hopper and pneumatic equipment, which can also be used for extraction. Aeration is through a duct and fumigation through 1/2 in (12mm) diameter pipes inserted at equal intervals on the periphery. Inherent limitations of slow receipt, dispatch and drying facilities make the bins unsuitable for high turnover.

The new reinforced concrete vertical silos are similar to grain elevators in Western countries and are constructed of concrete reinforced with steel. Capacity is generally more than 10,000 t. A conical hopper bottom is 13-1/3 ft. (4.1m) above the ground. For feeding from the top, a hopper empties bags on to a conveyor belt. For reclamation a conveyor runs under the hoppers. Aeration is from the top by fans installed in the head house, and the air escapes through openings in the hopper bottom. The silos also have a temperature recording system. Improved types are being built in Punjab and Uttar Pradesh.

Compared to hopper bottom silos, the flat bottom-type has 25 percent more capacity, with the disadvantage of slow emptying and hand cleaning. For high throughputs it would be feasible to use hopper-bottom vertical silos with built-in electrical and mechanical equipment for grain handling. Vertical silos, recognized as the best form of bulk storage from the point of view of better aeration and faster handling, are quite expensive. These need to be adopted, if at all, only at strategic locations such as ports.

CAP or open-storage techniques were evolved by the FCI as a short-term measure for transit purposes in 1971/72. They have all the essential features to meet urgent needs in arid and low-rainfall areas for all hardy and non-hygroscopic grains. CAP storage provides reasonable protection, but requires more care and effort to preserve stocks. The grain, largely wheat, is stored in bags on a brick plinth with wooden crates. Each unit can hold 1,500 bags 15 to 20 high, on an area of 20 ft x 30 ft (6.1 m X 9.1 m), covered with black polythene and tied with nylon ropes, to protect it against wind and storm.

The selection of appropriate storage technology for India is influenced by various factors and criteria, such as the following:

Bulk or bag handling
Period and purpose of storage and type of grain
Whether the facility is for various grain types or only one
Capital investment
Operating or recurring cost per tonne of grain handled
Storage worthiness, incidence of losses and preservation costs
Operating returns, savings achieved by curtailment of workforce
Demand time and construction period
Existing mix of facilities
Marketing, transportation and storage infrastructure, facilities and practices

The comparative economics of bag and bulk storage could broadly be discussed in relation to initial investment, construction period, suitability for storage, preservation costs, and operating costs and returns. The comparative costs of units or complexes of 50,000 t, with all infrastructural facilities such as railway sidings and ancillary buildings, will be considered. Estimates of initial capital construction costs per tonne, inclusive of engineering services, supervision and contingencies, are as follows:

| Type of facility | Cost (dollars per tonne) |
|---|---|
| Conventional godown complex | 50 |
| Bulk-storage, inland concrete silos | 150 |
| High-turnover port silos | 300 |

For silos the figures include mechanical handling equipment. Matching infrastructure for bulk storage would also, however, require huge investments in India.

Estimated construction times are two years for a conventional godown complex, including six months as a preparatory period, and 3½ to 4 years for reinforced concrete silos (6-12 months preparatory). Some godown units may become available during construction of a complex. Bulk storage is unsuitable for milled rice, some millets and pulses, for which bag storage is most appropriate. It is only for cereals and their milled products that bulk structures are suitable.

Bagged grains stored in godowns can be kept satisfactorily up to two years under the most suitable dry climatic conditions. In coastal areas, however, the period is only between 8 and 12 months. On the other hand, the shelf life of grain silos can be up to five years irrespective of location. Estimated losses are about 1 percent per year in godowns and 0.2 percent in bulk storage silos, irrespective of the time involved. Thus losses and preservation costs are much lower in bulk storage structures, rotation problems can be avoided, and operational and handling costs reduced. In fact, advanced storage technology provides the answer which is technically most feasible, except for the huge capital investments required for both the structures and parallel facilities, and the need for drastic changes in the entire food-grains marketing and handling systems.

Operating costs, which vary substantially, are also important. Bulk-storage facilities are more capital- and less labor-intensive. It might appear that operating costs would be less with godowns, given their labor requirements. But the operational economies of larger throughput with less handling costs and smaller storage losses, coupled with less preservation cost, reduce the unit costs considerably with each additional turnover in silos, where handling capacity is high and there might be more than one turnover. Some advantages of the integrated system with bulk storage and equipment are quicker handling, freedom from rodents and insects, easy aeration and fumigation, and greater usable area. Bulk movement becomes cheaper, quicker and safer. More importantly, the grain can be stored for three to five years. Though initial costs are high, the operational cost is lower.

It is in the context of the country's recent shift from an era dominated by scarcities and imports to an era of surplus production, and consequent increase in the volume of transactions and stocks, that the need for advanced storage technology has been realized. Overall storage gaps have been estimated at not less than 3-4 million tonnes.

Shifting to advanced storage technology. Advanced storage technology does have disadvantages that will slow down the shift from traditional technology. These include adverse effects on employment, possible underutilization of capacity, and large initial investments. Large scale farms are rare in India; the economies of large scale operations through bulk storage may not be possible in many producing areas. When the peak marketing periods of some crops are concentrated over two to three months, failure to use the facilities during slack periods may be wasteful. Shortages of high-level operating skills or construction materials and longer construction times could also hamper a switchover. It has therefore been considered appropriate that the transformation be introduced gradually.

A few silo and bin structures have been installed experimentally, and bulk storage capacity of 383,000 tonnes exists at 12 centers. Moreover, a program for additional installations has been initiated with the financial assistance of the World Bank; five silos,each with a capacity of 20,000 t, are being constructed in Punjab and Uttar Pradesh under this project. Bulk transportation is an essential element in an integrated system of grain procurement and bulk storage, and its distribution in bulk or bag. To provide a link between producing area silos and distribution silos, and to facilitate operation of an integrated system, a pilot project is coming into operation under the World Bank program; the proposed facilities would eliminate the need for bagging grain for transfer to the centers. Alternatively, farmers may deliver direct to the procurement centers where the grain would be graded, weighed and conveyed into elevator steel hopper bins to be kept in bulk until carried to storage points. The pilot project also foresees provision of carriers to move the grain from market yards to the rail-head terminal. Improvisation of flat bulk railway wagons and the provision of special train wagons have also been envisaged.

Bulk-cum-bag storage structures are also being built at about 20 centers for the first time. Such structures could appropriately be described as intermediate storage technology, incorporating both traditional and advanced characteristics.

Unless introduced in phases, advanced storage technology, though widely adopted in developed countries, would not be entirely appropriate to present Indian conditions. It would therefore be useful to consider a middle road providing the advantages of advanced storage technology without having to invest so much in silos and infrastructure. Such an approach involves an ideal combination of conventional and advanced storage technology, with basically wide-span structures to hold substantial quantities of grain in bulk. Initially used for bags, the capacity for bulk storage will be much greater. Mechanical handling could be incorporated later; only the warehouse portion is first needed. Since considerable progress has already been made towards developing bulk handling and transportation facilities in major states holding surplus grain, it may be appropriate to adopt intermediatate storage technology in the form of bulk-cum-bag storage structures, with complete mechanical handling facilities. Arrangements for aeration, fumigation of grain, temperature detection, etc. would be based on successful experiences in Australia over the last two decades.

The storage gap identified today is primarily due to the increased storage requirements for buffer stocks. Planning for the future should take into account not only the choice of storage techniques, but also economies of scale flowing from godowns or complexes of different capacities. Large-size units or complexes in various combinations are suggested, depending upon requirements varying from region to region.

[Extracted from Appropriate Technology for Food Storage and Processing pp. 58-74. Monograph No. 7 in the UNIDO series on Appropriate Industrial Technology, United Nations, New York,1979.]

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U.S. GOVERNMENT PRINTING OFFICE: 1980—310-928/4

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